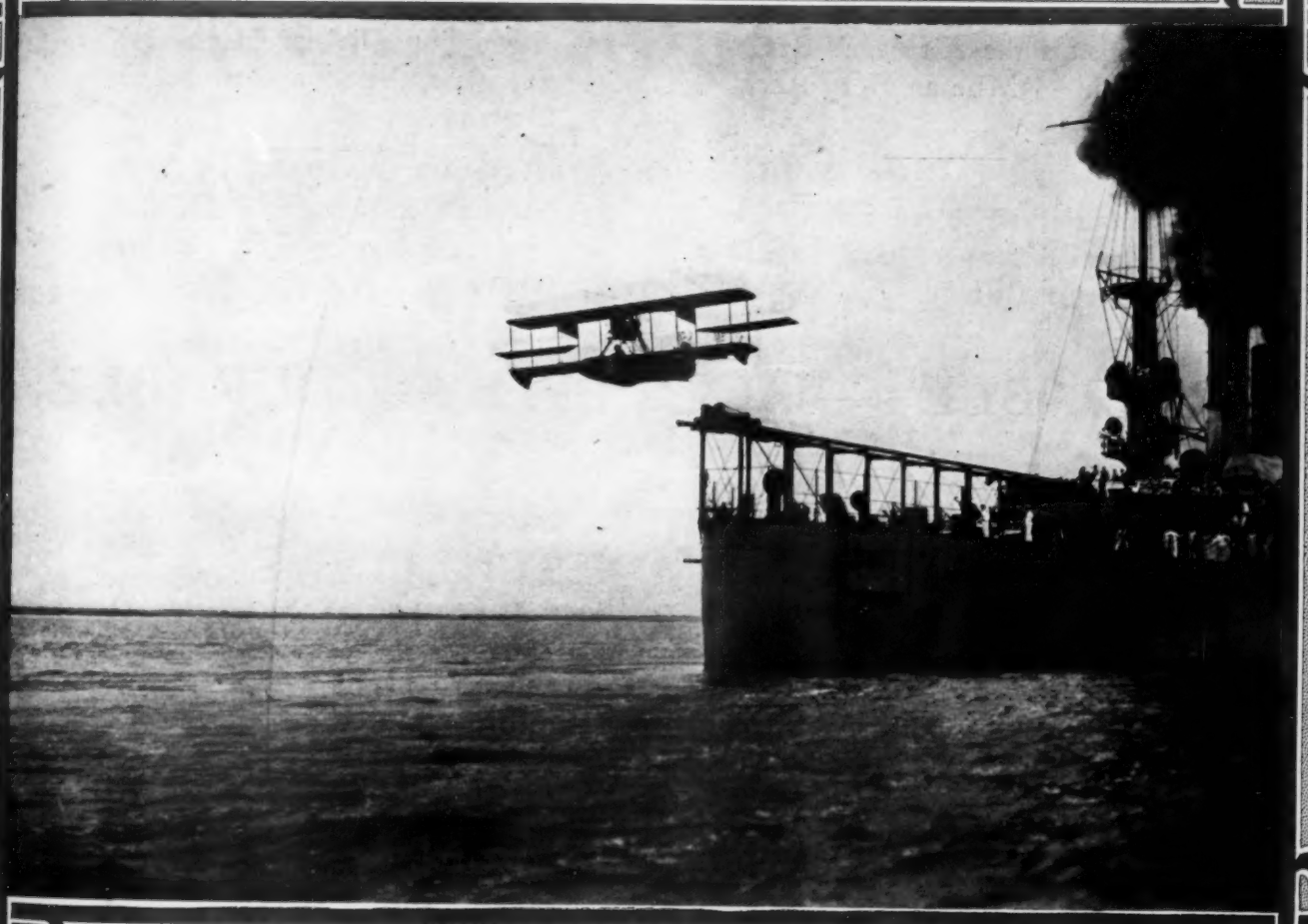
AVIATION
AND
AERONAUTICAL ENGINEERING



Launching a Flying Boat from the Deck of a Battleship

JUNE
15th
1917

SPECIAL FEATURES

THE ROYAL FLYING CORPS, CAMP BORDEN

MATERIALS IN AIRPLANE CONSTRUCTION

COURSE IN AERODYNAMICS AND AIRPLANE DESIGN

ORGANIZATION OF U. S. ARMY AIR SERVICE

THE AIRCRAFT INDUSTRY IS PREPARED

OBSERVATIONS ON PHYSICAL EFFECTS OF FLYING

PRICE
Fifteen
Cents

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER, MOFFAT CO., Inc.
120 W. 32nd ST. NEW YORK

AERONAUTIC PROGRESS

Announcing

TWO NEW SPERRY INSTRUMENTS
FOR AVIATORS

SPERRY Air Speed Indicator

Registers the Airplane's Speed within ½ Mile an Hour Accuracy.

Either True Air Buoyancy or Actual Air Speed Easily Read for Any Altitude.

SPERRY Altimeter

Revolving Dial of High-Visibility Can be Set at Zero before Starting.

Accurately Records Altitude from the Earth—Not Distance above Sea Level.

RELIABLE —— ACCURATE —— DURABLE

MAXIMUM VISIBILITY
DAY OR NIGHT

Both Instruments Have Black Dials with White Figures, Radium Painted

Small — Simple in Design — Compact

These Instruments are the Result of Years of Research and Investigation

UNAFFECTED BY VIBRATION
OR ACCELERATION

The SPERRY GYROSCOPE COMPANY

MANHATTAN BRIDGE PLAZA BROOKLYN, N. Y., U. S. A.

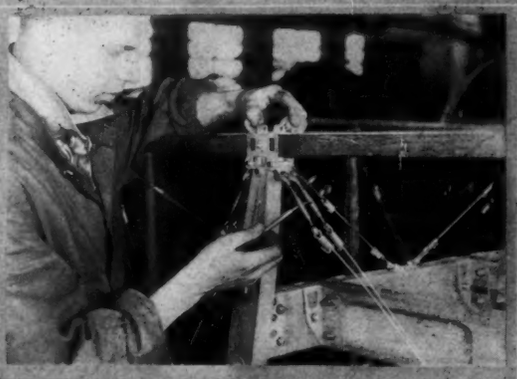
Paris—126 Rue de Provence 15 Victoria St.—London, S. W.

AN EDUCATIONAL PRESENTATION BY THE

STANDARD AERO CORPORATION

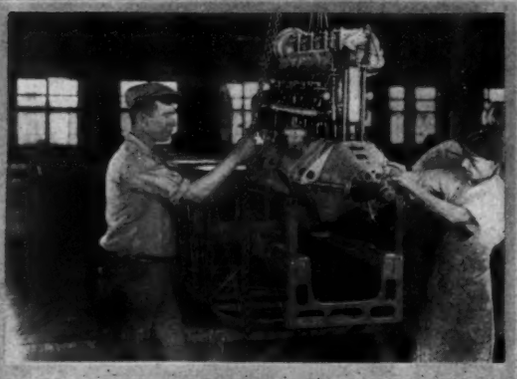
SHOWING A FEW OF THE STEPS IN THE MANUFACTURE OF AIRPLANES

Finishing touches to the propeller bring it to perfect balance.



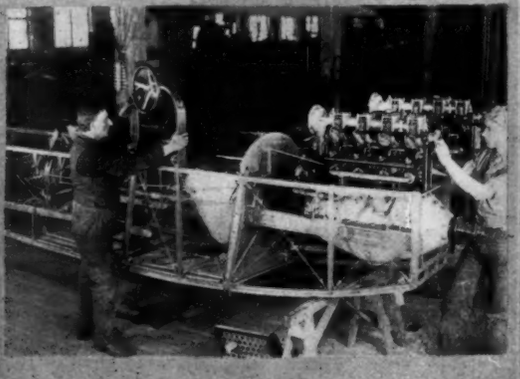
Every wire at each station in the fuselage is tuned to the proper degree of tautness.

The propeller being gauged during the process of planing.



Not until the fuselage is absolutely aligned is the motor put in its place.

The lower longerons are laid out on the fuselage bed & the struts carefully located.



Tanks, instruments and controls are quickly placed, once the fuselage is aligned.

Factory No. 1, April 1, 1917
Area of 27,000 Square Feet

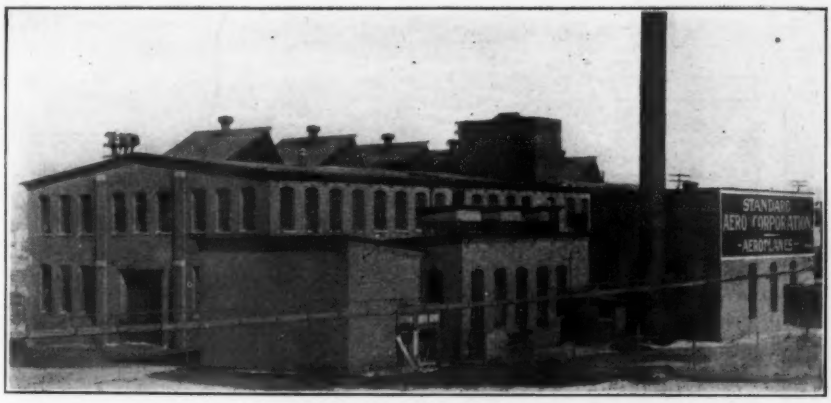
STA
EXP

Factory No. 1, June 1, 1917
Area of 62,000 Square Feet

Paint Shop, Factory No. 1

The Standard Co. also has the exclusive use of four other plants, two for turning out metal parts and two for wood working, with a total floor space of 40,000 square feet.

DARD
NSION



Factory No. 2, April 1, 1917
Area of 22,000 Square Feet

Factory No. 2, June 1. 1017
Area of 54,000 Square Feet

Contractors to U. S. Army and Navy

STANDARD AERO CORPORATION

EXECUTIVE OFFICES, WOOLWORTH BLDG., N.Y.C.
FACTORY, PLAINFIELD, NEW JERSEY

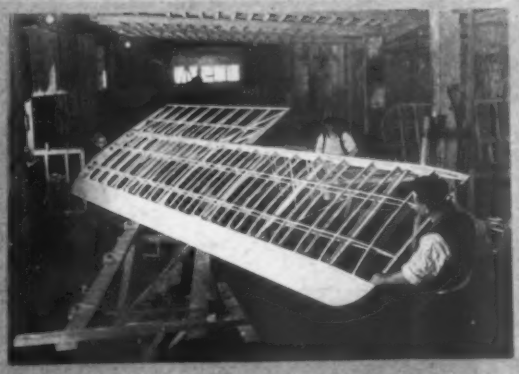
Member Aircraft Manufacturers' Association, Inc.

Group of Employes in Metal Department Listening to Liberty Loan Address by President Mingle

AN EDUCATIONAL PRESENTATION BY THE

STANDARD AERO CORPORATION

SHOWING A FEW OF THE STEPS IN THE MANUFACTURE OF AIRPLANES



The completed wing - a splendid, graceful structure. Note wiring through rib construction giving rigid bracing.

Frequently gauging the struts assures a perfect streamline form.

Ribs are assembled with the greatest accuracy & each part shaped to conform to the proper curve.

The trained eye readily detects the slightest flaw in the construction of the wing strut.

Last stage of wing manufacture. Note the partly covered wing in the rack at right.

Every spoke in the landing wheel is adjusted to stand the strains for which it is built.

Thomas

Contractors to U.S. Army and Navy

THOMAS-MORSE AIRCRAFT CORPORATION
ITHACA, N.Y. U.S.A.

Member Aircraft Manufacturers Association

"USCO" NUMBER 72

THE STANDARD KITE BALLOON FABRIC OF AMERICA

A TWO-PLY BIASED FABRIC, COATED BETWEEN PLIES WITH A LIGHT, TOUGH LAYER OF PURE PARA RUBBER.

THIS FABRIC HAS BEEN DEVELOPED FROM YEARS OF LABORATORY EXPERIENCE, AND POSSESSES EVERY FEATURE AND QUALIFICATION NECESSARY TO A WELL-BALANCED PRODUCT, VIZ.:

STRONG
GAS-TIGHT
NEUTRAL, INVISIBLE COLOR
WITHSTANDS ALL WEATHER CONDITIONS
AND AGES WELL

UNITED STATES RUBBER COMPANY AND ASSOCIATED COMPANIES — US — RUBBER SYSTEM

MADE BY THE
WORLD'S LARGEST RUBBER COMPANY

UNITED STATES RUBBER COMPANY
NEW YORK

"NORMA"

"NORMA"

BALL BEARINGS

(Patented)

Your airplane is no better than its engine—your engine is no better than its ignition—your magneto is no better than its bearings. So small a thing as the magneto bearings may work havoc with your reputation. In the world of magnetos, "NORMA" Bearings identify units of proved dependability.

Therefore — see that the magnetos you use are "NORMA" equipped.

THE NORMA COMPANY OF AMERICA
1790 BROADWAY NEW YORK

Ball, Roller, Thrust and Combination Bearings.

"NORMA"

JUNE 15, 1917

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. II. NO. 10

Member of the Associated Business Papers

INDEX TO CONTENTS

	PAGE
Editorial	435
Materials in Airplane Construction	436
Course in Aerodynamics and Airplane Design	440
Aeronautical Patents	444
Statoscopes	444
Observations on Physical Effects of Flying	445
Organization of U. S. Army Air Service	447
The Aircraft Industry Is Prepared	448
Summer Meeting of the S. A. E.	453
Col. William Mitchell	453
Borden Field	454
Army Orders	456

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET NEW YORK

SUBSCRIPTION PRICE: TWO DOLLARS PER YEAR. SINGLE COPIES FIFTEEN CENTS. CANADA AND FOREIGN: TWO DOLLARS AND A HALF A YEAR. COPYRIGHT, 1917, BY THE GARDNER, MOFFAT COMPANY, INC.

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH. FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

THE ACKERMAN WHEEL

due to its resiliency and superior strength, has come to the front and is acknowledged as logical equipment for airplanes.

"IT'S IN

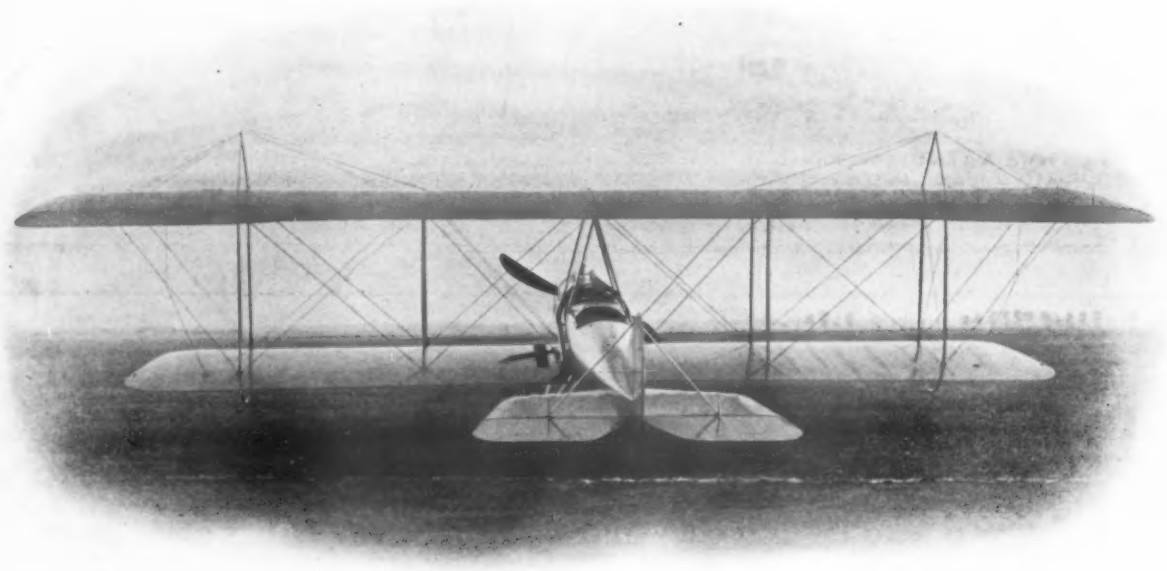
THE SPOKES"

Write us for suggestions in building landing gear and axles for use with ACKERMAN WHEELS.

Wheels built for any weight machine from 500 pounds and up.

THE ACKERMAN WHEEL CO.

ROCKEFELLER BUILDING, CLEVELAND, O.



·L·W·F·ENGINEERING·COMPANY·

PRESIDENT AND EDITOR
LESTER D. GARDNER

MILITARY EDITOR
1st Lieut. PHILIP J. ROOSEVELT*
*Absent on duty, Aviation Section, U. S. A.

AVIATION
AND
AERONAUTICAL ENGINEERING

TECHNICAL EDITOR
A. KLEMIN, A.C.G.I., B.Sc., S.M.,
Instructor in Aeronautics
Massachusetts Institute of Technology

BUSINESS MANAGER
GEORGE NEWBOLD

Vol. II | June 15, 1917 | No. 10

IF it were possible to give an account of the happenings of the last two weeks at Washington, it would become evident that at last plans are being considered which will, if carried out, put the United States in the war in the air as an important factor.

Conferences have been held with the Army and Navy, the Aircraft Production Board, manufacturers of airplanes and possible producers of engines and fittings. The foreign officers have been giving detailed information at these meetings which has expanded the plans of this country to what appears to be a program of at least one hundred thousand airplanes, calling for the immediate expenditure of nearly $600,000,000, with an ultimate budget of a round billion.

But more important than the plans for the future is the decision to furnish immediately airdromes in this country with standardized equipment which by September will enable the camps to produce one thousand aviators a month for our allies.

Already orders have been put under way for the parts and engines of the machines designed for this work, and as soon as the present appropriation becomes available larger orders will be given immediately.

If the necessities of this country are to be met Congress must act at once without delay and postponement. The people of the country are aroused to the needs of the air service and will give their support to army appropriations which our allies believe will help win the war.

The Department of Aeronautics

Hearings have been held on the bill to create a new member of the Cabinet to be the head of a Department of Aeronautics. General sentiment seems to be in favor of such a department, but whether or not the development for the present cannot be entrusted to the joint action of the Army, Navy and civilian advisers, will have to be given careful consideration.

The chart which appears elsewhere in this issue, giving the organization of the air service, will do much to clear up the muddled condition of public information regarding the activities of the various agencies at work on aerial development.

The Aircraft Production Board, it should be clearly understood, is acting in an advisory capacity only, and derives its authority from the Council of National Defense. It was appointed at the request of the National Advisory Committee for Aeronautics. Howard E. Coffin, who is a member of the Advisory Commission of the Council, was requested to appoint such a board, and the membership was selected by him. It, therefore, as is shown by the chart, acts through the Cabinet members who are members of the Council. Much of the red tape has been cut by the appointment of General Squier and Admiral Taylor on the board. It is understood that the Board is paying its own expenses until an appropriation for its work becomes available.

If an efficient air service is to be built up and civilian advice is to be sought, more authority should be given than the Aircraft Production Board now has and more responsibility required. The reputation of the members of the Board is such that they have secured general public confidence, but the experience of our allies with boards should be given the closest study so that we may profit by their experiences. The general impression seems to be that a department of aeronautics will soon take equal rank with the Army and Navy. If this is true the sooner we start right the better.

The Need for Personnel

The pictures of the Royal Flying Corps Field at Camp Borden, Canada, printed on another page of this issue, must make clear to anyone that there is a serious problem in the training of cadet military aviators aside from that of equipment.

The large number of instructors, mechanics and other personnel needed to train a few cadets is evident, and one of the most immediate of our needs is a plan to secure these recruits for United States Army flying fields. Expert mechanics are hard to secure at present in any industry notwithstanding the high wages offered. The Government will have to make this branch of the service very attractive to this type of recruit to secure them in the numbers needed.

Of the greatest importance is the flying instructor. These exceptional men can only become available through experience and this can only be acquired by time. If the vast number of cadet aviators are to be well trained this serious requirement will have to be considered immediately.

It has been stated that French and English flying instructors would be sent to this country to assist in training our cadet aviators. If this is to be done, a part of the problem will be solved, but to use the thousands of airplanes that are to be produced to the best advantage a special provision must be made for the production of instructors. Otherwise the vast program of production will be clogged at its most vital point.

Materials in Airplane Construction*

By N. L. Liebermann

Specification Engineer, The Curtiss Aeroplane Co.

Linen

A proper determination of the desirable physical properties of linen must be based on an analysis of the linen under load.

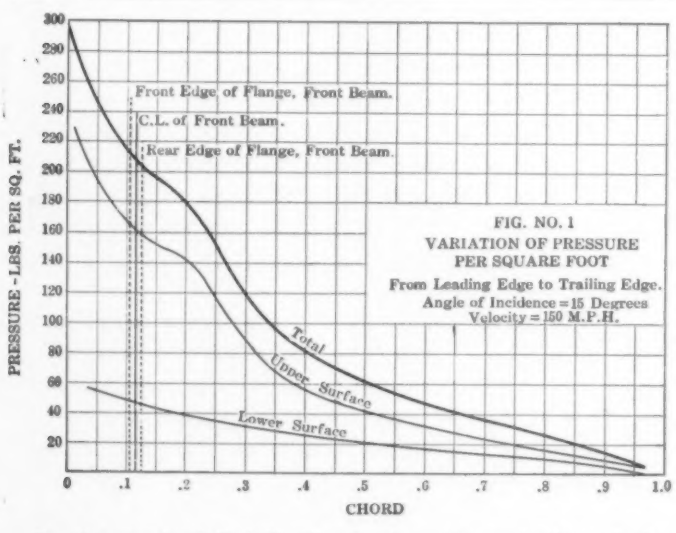
The use of linen as a structural material is comparatively new. On this account there exists a great variation in the requirements which this material must satisfy. The researches of the Royal Aircraft Factory have been, for several years, the standards upon which the strength of doped and undoped linen is based. The method has generally been to request samples from several mills, and set as a standard the highest quality obtained. While this method has the advantage of establishing a very high criterion, it simultaneously requires a material far in excess of the needs of the machine. A parallel case would be if it were required to make all steel parts of nickel-chrome steel, because this material demonstrates superior qualities to ordinary carbon steel.

An airplane entering on a nose dive, and descending about 2,000 ft., would be moving about 100 to 150 m.p.h., depending on the size of panels, stream-line adaptations, etc.

If the airplane now be straightened out, so that the panels pass through the critical angle for the wing curve, the maximum possible pressure on the linen will be exerted. For discussion, an R.A.F. No. 6 curve may be assumed. The critical angle is about 15 deg. For a median section on the panel (where the air pressure distribution is practically constant, parallel to the leading edge), the maximum suction on the upper surface has been found by laboratory experiments to be $2.0pv^2$ ($= 2.0 \times .0051v^2$ lb./sq. ft., in which $v =$ miles per hour). The following table and curve represent the estimated pressure at 150 m.p.h., on an R.A.F. No. 6 wing curve, at 15 deg. angle of incidence.

TABLE NO. 1

Distance from leading edge	Suction, lb. per sq. ft. on upper surface	Pressure, lb. per sq. ft. on lower surface
.010	229.50	56.00
.100	166.50	49.20
.200	142.50	36.90
.400	56.00	27.80
.600	31.20	16.75
.800	16.20	10.65
.967	5.73	0.00


PRESSURE - LBS. PER SQ. FT.
CHORD
Front Edge of Flange, Front Beam.
C.L. of Front Beam.
Rear Edge of Flange, Front Beam.
Total
Upper Surface
Lower Surface
FIG. NO. 1
VARIATION OF PRESSURE PER SQUARE FOOT
From Leading Edge to Trailing Edge.
Angle of Incidence = 15 Degrees
Velocity = 150 M.P.H.

In the standard R.A.F. No. 6 wing, the centerline of the front beam, in practice, is approximately .115 chord from the leading edge—indicated by the heavy line. Allowing about 0.010 chord additional for half the flange thickness, the two dotted lines represent the limits of the area directly supported by the front beam.

The general type of panel used in current practice is designed with a rigid covering on the upper surface, from the leading edge to the front beam. This is generally a wooden veneer. The area covered by the linen commences at the rear edge of the upper flange of the front beam. The bottom surface is generally completely covered with linen.

Controlling Factors

The tension in the linen is dependent upon several factors, among which may be mentioned, (1) the span or distance between centerline of ribs, (2) the loading, and (3) the initial tension in the linen, due to the application and shrinking of the dope.

The first factor is practically constant for any given location in the panel.

The loading is a variable force, depending upon the location in the span of the panel, and generally decreasing from the leading to the trailing edge. This factor attains its maximum value at the critical angle for the given wing curve.

The doping, as first applied to the linen, induces an initial stress, as it dries and shrinks on the covering. This is evident from the tautness and slight concave sag noticeable between the ribs of a new panel when viewed in the direction of the chord. The exact amount of this force, however, is dependent upon so many factors, governed by the chemical composition, humidity at time of drying, thickness of application, texture of the linen, etc., that it cannot be stated with any degree of accuracy, even in an empirical formula. Furthermore, due to the general instability of the dope coating, its tendency to sublimate (cellulose nitrate) or crack (cellulose acetate), the initial state of tension is soon relieved, and ultimately lost. The linen, however, still retains the dope with which it was impregnated, thus remaining practically air-tight. The surface tension, however, may be considered as having been removed.

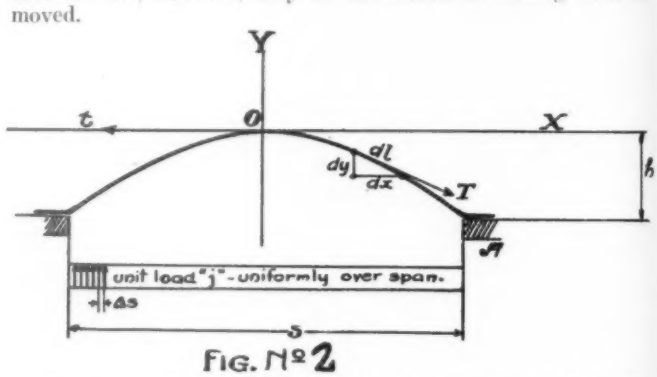


FIG. Nº 2

This leaves the first two items as the major controlling factors. In Fig. 2, it is assumed that the linen under load has stretched sufficiently to form the indicated contour. For the major portion of the panel, the load is applied uniformly (transverse to the axis of the machine).

Assume a unit load j applied uniformly over the span. Since the linen is in equilibrium, it may now be regarded as a rigid member. Furthermore, it is also the line of the equilibrium polygon of all the forces acting on it. The load may be divided into small equal units, each Δs long (therefore $j =$ load over "Δs" position of the span). Since the unit load may be assumed to be concentrated at its "center of mass," the point of application of each unit load is Δs distance apart.

Let $l =$ length of the linen between supports
$s =$ span between supports
$h =$ maximum vertical displacement due to load
$X =$ sum of the x-components of the external forces between O and A
$Y =$ sum of the y-components of the external forces between O and A
$T =$ tension of the linen at any point
$t =$ tension of the linen at the highest point

From the diagram the x-component of T at any point $= t_x = T\frac{dx}{dl}$; also the y-component of T at any point $= t_y = T\frac{dy}{dl}$

For the part OA, the conditions for equilibrium are

* Copyrighted 1917 by N. L. Liebermann.

$$\Sigma X = O \qquad T\frac{dx}{dl} - t = O \ldots\ldots\ldots\ldots (1)$$

$$\Sigma Y = O \qquad T\frac{dy}{dl} + Y = O \ldots\ldots\ldots\ldots (2)$$

Since $Y = -jx$: equation (2) becomes

$$T\frac{dy}{dl} - jx = O \ldots\ldots\ldots\ldots\ldots (3)$$

From equation (1) and (3), the expression $y = \frac{jx^2}{2t}$ is derived. This equation contains three unknowns, x, y, and t. The value of t in terms of the conditions may readily be determined by substituting $x = \frac{s}{2}$ and $y = h$ in the above expression.

The equation of the curve which the linen assumes, when loaded uniformly across the span, may then be reduced to

$$y = \frac{4hx^2}{s^2} \ldots\ldots\ldots\ldots\ldots (4)$$

The form of the equation indicates a parabola, depending on the value of h. The tension in the linen at any point is indicated by the formula

$$T = t\ \frac{dl}{dx} = t\left[1 + \left(\frac{dy}{lx}\right)^2\right]^{\frac{1}{2}} \ldots\ldots\ldots (5)$$

which reduces to

$$T = \frac{js^2}{8h}\left[1 + \left(\frac{16h^2}{s^2}\right)^2\right]^{\frac{1}{2}} \text{ at the ends} \ldots\ldots (6)$$

$$\text{and } T = \frac{js^2}{8h} \text{ at the center of the span.. } \ldots\ldots (7)$$

It then becomes evident that the stress increases from a minimum value of $\frac{js^2}{8h}$ at O to a maximum value of $\frac{js^2}{8h}\left[1 + \frac{16h^2}{s^2}\right]^{\frac{1}{2}}$ at the edge of the cap strip.

In both these values, as in the equation of the curve assumed by the linen under load $\left(y = \frac{4hx^2}{s^2}\right)$, the term h or "rise" appears. The rise is a factor depending upon the load, length of the span, and stretch of the linen.

The percentage of stretch of the linen depends on a series of variables. Fig. 3 shows graphically the results of some tests performed by the R.A.F. on undoped linen. The line assumed as representative of the stretch is based on a high grade, close warp and weft linen, with an ultimate strength of about 96 lb. —the stress being applied 45 deg. to both the warp and weft. This assumption allows 8 lb. loading per inch width per per-cent elongation for each inch of length; or 0.125 per cent elongation per inch for each pound loading per inch width. Using the above notation, the length of the linen under loading will be

$$l = s(1 + .00125T) \ldots\ldots\ldots\ldots\ldots (8)$$

If this value be equated to the length of the linen obtained from the curve assumed due to loading, a relation between h and s may be established. The equation of the curve is

$$y = \frac{4hx^2}{s^2}, \text{ from which } dy = \frac{8hx}{s^2}\ dx$$

substituting $\frac{1}{l} = \frac{8h}{s^2}$ in the above and developing $dl = \sqrt{dx^2 + dy^2}$, we have $dl = \frac{\sqrt{b^2 + x^2}}{b}\ dx = \frac{b\,dx}{\sqrt{b^2 + x^2}} + \frac{x^2 dx}{b\sqrt{b^2 + x^2}}$ from which may be determined

$$l = \frac{s}{2}\left[1 + \frac{16h^2}{s^2}\right]^{\frac{1}{2}} + \frac{s^2}{8h}\log_e\left[\frac{4h}{s} + \left(1 + \frac{16h^2}{s^2}\right)^{\frac{1}{2}}\right] . (9)$$

This gives the exact length of the curve assumed by the linen under load. From equations (8) and (9), the absolute values of h may be determined. A very close approximation and more readily handled formula may be obtained as follows:

$dl = \sqrt{1 + \left(\frac{dy}{dx}\right)^2}$ from $y = \frac{4hx^2}{s^2}$, $\frac{dy}{dx} = \frac{8hx}{s^2}$, hence $dl = \sqrt{1 + \frac{64h^2x^2}{s^4}}$, hence $l = 2\int_o^{\frac{s}{2}}\left(1 + \frac{64h^2x^2}{s^4}\right)^{\frac{1}{2}} dx$

Expanding the term under the radical by the binomial theorem,

$$\left(1 + \frac{64h^2x^2}{s^4}\right)^{\frac{1}{2}} = 1 + \frac{32h^2x^2}{s^4} - \frac{512h^4x^4}{s8}$$

from which $l = s\left(1 + \frac{8h^2}{3s^2}\right)$ ..... (10)

Since all values of $\frac{h}{s}$ from $\frac{h^4}{s^4}$ inclusive, and on, are very small and unaffecting on the general result.

Combining the two values of l, $s(l + .00125T) = s(l + \frac{8h^2}{3s^2}$

hence $$T = \frac{6400h^2}{3s^2} \ldots\ldots\ldots\ldots\ldots (11)$$

The value of T at the top of the stressed linen is $\frac{js^2}{8h}$. Hence, if w = the loading over the span, per inch width, $(= js)$, and the above value of T be substituted in equation (11), we have

$$h = \frac{s}{8}\sqrt[3]{\frac{3w}{100}}$$

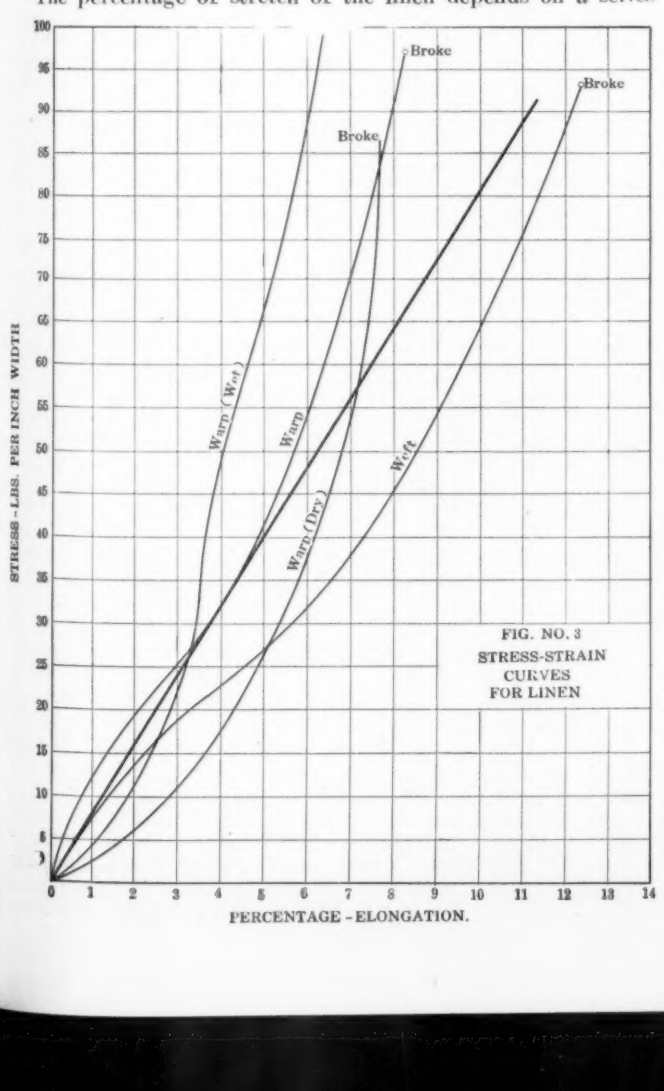


FIG. NO. 3
STRESS-STRAIN CURVES FOR LINEN

Distortion of Linen

Substituting the value of h thus obtained, in the formulas for the maximum and minimum values of T, we can determine the tension at the center and ends of the span.

As previously mentioned, the upper surface of the panels, from the leading edge to the front beam, is covered with some rigid material, generally wood veneer; with a view of maintaining the proper "entering contour," and also to resist the high tension induced by the suction. Under the conditions above assumed (velocity 150 m.p.h., and the machine straightening out from a nose dive), the upward lift on the front edge would have a maximum value of approximately 298 lb. per sq. ft., or 2.07 lb. per sq. in. If linen were used as the covering, and the distance between the inner edges of the ribs be taken as 15 in., the loading on the linen per inch width in the direction of the chord would be $15 \times 2.07 = w - 31.05$ lb. The distortion of the linen would be $h = \frac{15}{8}\sqrt[3]{\frac{3 \times 31.05}{100}} = 1.84$ in.

The tension in the linen is then $T = 35.2$ lb. per linen inch width. While this would allow a factor of safety of 2.72, the longitudinal contour of the panel would be extremely distorted by the "rise" in the span of the linen.

From the curves represented in Fig. 1, the total loading on

the linen at the rear edge of the flange, front beam would be a maximum when the lower surface covering is broken. In this case, the loading on the upper surface would be the combined values = 204 lb. per sq. ft. = 1.415 lb. per sq. in., for a width of one inch, measured along the chord. Assuming again, 15 in. as the distance between the inner edge of cap strips (this allows about 16 in. center to center of ribs), the total loading on the strip of linen 1 in. wide equals $15 \times 1.415 = 21.22$ lb.

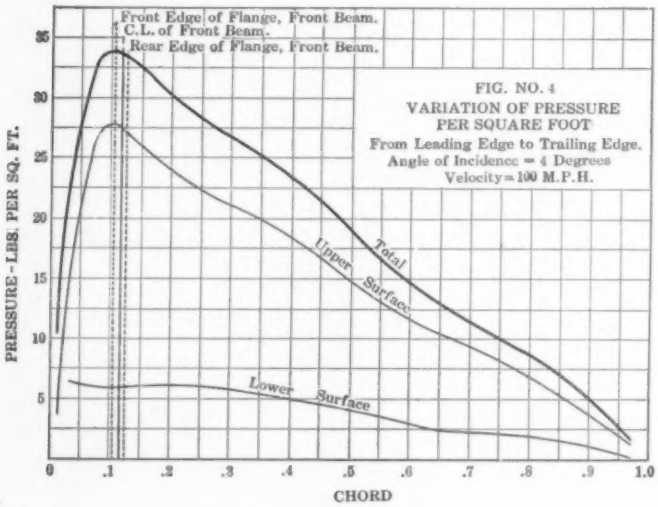
The rise, $h = \frac{15}{8}\sqrt[3]{\frac{3 \times 21.22}{100}} = 1.61$ in.

Factors of Safety

The tension in the linen for the above value of h will be 27 lb. per inch width. This allows a factor of safety = 3.56, on the basis of 96 lb. ultimate strength. The above rib spacing assumed is rather high, but, even under these conditions, the linen is safe. With the average spacing of ribs taken as 13 in. center to center, or 12 in. clear span, the tension $T = 22.92$ lb. per inch width, which gives 4.2 as a factor of safety.

The above conditions, of course, are extremely severe, and only encountered on comparatively rare occasions. Under normal conditions, the velocity may be assumed at 100 m.p.h. as the critical case. Since the pressure varies as the square of the velocity, the corresponding values for 100 m.p.h. would be $\frac{100^2}{150^2} \times \frac{204}{T} = 90.78$ lb. per sq. ft., or 0.63 lb. per sq. in., for which $T = 13.50$ lb. per inch width on 12 in. clear span, with 7.1 as a factor of safety.

If the machine be flying at some normal angle of incidence, say 4 deg., at 100 m.p.h., the pressure variation would be represented by Fig. 4.


Front Edge of Flange, Front Beam.
C.L. of Front Beam.
Rear Edge of Flange, Front Beam.
FIG. NO. 4
VARIATION OF PRESSURE PER SQUARE FOOT
From Leading Edge to Trailing Edge.
Angle of Incidence = 4 Degrees
Velocity = 100 M.P.H.
Total
Upper Surface
Lower Surface
PRESSURE - LBS. PER SQ. FT.
CHORD

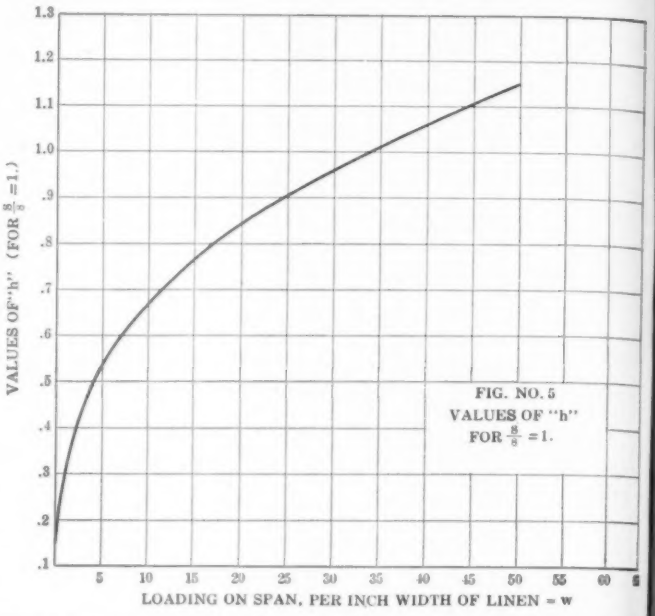
By an analysis similar to the preceding, $T = 6.52$ lb. per inch width, for 12 in. span, and 7.75 lb. per inch width for 15 in. span, with 14.7 and 12.4 respectively as a factor of safety.

In Fig. 5, the values of h have been plotted, for various loads on the span, of unit width (1 in.), with the factor $\frac{s}{8} = 1$. This, of course, is the same as the deflections on an 8 in. span. For any other width of span, the deflection is the value of h corresponding to the loading, multiplied by the factor $\frac{s}{8}$.

The entire foregoing discussion clearly shows that the linen requirements demanded by present practice are very high. Only under rare occasions does the tension rise over 25 lb. per inch width. A factor of safety = 5, with the average loading 15 lb. per inch width, would require a linen of 75 lb. per inch width ultimate strength. This value would permit the use of many fabrics which to-day are excluded by the high physical values demanded, and prevent the rejection of otherwise good and readily procurable linens.

Dope

There is no doubt that the ideal dope should be a cellulose ester. The particular choice between a nitrate or an acetate, or a combination of the two, or even some other formula, is a matter which has not yet been fully determined by laboratory research. One of the difficulties in arriving at a suitable base in making dopes is the inability of selecting a convenient solvent. The physical and chemical analysis given for the rapid breaking down of dope is the too rapid evaporation of the liquid of solution, or sublimation of the solids of solution.



Further, certain desirable bases are soluble in certain vehicles only. The German "Celite," for example, is more readily soluble in acetone; whereas the cellulose nitrate is used generally with amylacetate.

Tetrachlorethane has the decidedly advantageous property of rendering a dried cellulose acetate solution very pliable and elastic; but the normal disadvantage in the use of this compound is the poisonous fumes given off in the handling. When the percentage of tetrachlorethane falls below ten, the advantages are not in proportion to the danger involved in the use of this combination. This, at least, is the present status in formulating dope. One of the fields in which researches are being made is the possibility that, perhaps, with a new solvent it will be possible to get a pliable dope, or, at least, one which will not evaporate as rapidly as the present compounds.

Disadvantages of Nitrates

The disadvantages of the nitrates are:

(1) The rapid evaporation of the solvent, alternately leaving little or no cellulose coating on the fabric.
(2) The inflammability of the coating, either wet, dry, or in fumes.
(3) Its unstable equilibrium in sunlight.

A probable explanation for the degrees in the thickness of the coating is that due to the evaporation of the solvent the cellulose nitrate will first shrink in the thickness dimension. When the surface tension has reached a certain point, the internal rearrangement under the surface skin causes a readjustment so that the planer dimensions are affected. This is the phenomenon known as shrinkage. From this stage on there is a gradual diminution in the thickness, progressing at a faster rate than the corresponding change in the planer dimensions.

There is undoubtedly a certain definite relation between the rays of the sun and the decomposition of cellulose nitrate dope, for this compound, when subjected to artificial heat of even greater range of temperature than that derivable from sunlight, does not show as great a diminution in volume, nor the breaking down of the radicals. Furthermore, given the same temperature of sun heat, but in two different lights, the action of the dope is different. That is to say, the actinic portions of the sun's rays are the destructive agents. Investigations in this direction can be very properly made with the aid of a spectroscope. While no results have as yet been published, or any definite experiments been made with this instrument, the analysis and method of attack would be very similar to that used in analyzing other compounds that are affected by the sun's light.

A film made of either an acetyl- or a nitro-cellulose compound, subjected to spectroscopic analysis, should individually give their distinctive spectra. If these be examined for different periods of time of exposure to the sun's rays, it may be expected that certain lines will be accentuated, due to some

internal rearrangement of the radicals. The co-relation between these lines and the decomposition of the dope would then offer a clue to further lines of study.

Cellulose acetate is affected by the action of the sun's rays in a different manner from that of the nitrate. The nitrate shows definite signs of evaporation. The solvents, while not evaporating as rapidly, dry out and leave a body to the deposit. This deposit is characterized by excessive brittleness, and, if physically disturbed, develops concentric cracks. These cracks are sharply defined, and would seem to indicate a high degree of surface tension.

Cause of Streaks

Streaks are the results of unequal evaporation in the body of the deposit. This is most probably due to the method of application with brushes. The brushes leave slight ridges or "hills and dales." It naturally takes longer for the ridges to dry than it does for the hollows. The percentage of amyl-acetate which evaporates from the thinner coating of cellulose nitrate dopes is greater than that from the heavier portion. This causes a condition of non-equilibrium between the two adjacent portions of the coating. The cotton is then precipitated in the thinner parts, due to this condition of unstable equilibrium, causing the well-defined streaks. This action is accentuated if the doping is done on humid or damp days.

A determination of any one physical constant for dopes does not necessarily give a clue as to its desirability. In cellulose nitrate, the specific gravity may be kept constant, while the percentage of solvent and of cotton may be varied. The viscosity number, at a given temperature, depends upon the age of the dope and its condition of exposure to the atmosphere. With the highly volatile solvents, a drum exposed for 24 hours may show an extremely high viscosity. The same general remarks are applicable to the temperature of the flash-point. However, by a careful control of the three factors, a uniform and satisfactory dope may be evolved.

In conjunction with the above constants, the dope should show distinct adhering and penetrating qualities when applied to fabrics; comparative solubility of "dried" dope in liquid dope; and reasonable resistance, when dry, to the action of the elements.

Airplane Engine Power Rating

By H. E. Morton

Aeronautical Engineer, B. F. Sturtevant Co.

Not only in the airplane engine industry but also among the automobile and motor boat engine builders there has always seemed to be about as many different methods of power rating as there are manufacturers. Referred to the actual possibilities in service some ratings are too high and some too low.

There should be some definite process by which the rating of an engine for each class of service may be arrived at. There can be little doubt as to the impracticability of rating an engine at the maximum obtainable from it when tuned up to the utmost and under ideal conditions. It is just as unsatisfactory to fix a rating which is decidedly lower than what is obtainable under ordinary conditions. The allowance in either direction should be uniform for all engines intended for any particular service.

The gasoline engine of the constant volume type, in direct contrast with the electric motor or steam engine, has no overload capacity at a fixed speed excepting a comparatively small amount, resulting from an over rich mixture. Therefore, an airplane engine cannot be overloaded so far as power developed is concerned. The term "overloaded" is often times misused in this connection to mean an overstressed engine. However, an overstressed engine in an overloaded plane might be loosely considered an overloaded engine, but in reality is either an over-rated engine or an engine operated considerably in excess of its safe rating.

The airplane engine when under load is practically a fixed speed engine, due to the fact that the power absorbed by a propeller increases as the cube of the speed, while the power developed increases as the first power or less. Properly rated, such an engine has no real overload capacity but must be designed to operate continuously at its rated power. Here is an important difference between an airplane and an automobile engine.

The automobile engine is anything but a fixed speed engine and through the transmission can be operated at speeds limited only by the driver's intelligence or the wrecking and stalling speeds of the engine. There can be no rated speed, although the normal speed will usually be that corresponding to a car speed of thirty miles per hour. But at this speed the engine is throttled. Probably the most severe service speed test with any duration on an automobile engine is imposed when the car is driven on a smooth, level track at the speed where the engine power at full throttle just equals the power absorbed by the car. Here, much the same as in the case of the airplane, with increasing speed the power absorbed increases much more rapidly than the power developed. Due to the possibility of much higher engine speed through the transmission there is some justification in rating an automobile engine at the peak of the power-speed curve.

Considering the airplane engine alone, the rated power may properly be allowed to fall below the maximum by a few per cent only as it is an accepted practice to spend the necessary time on the engines to keep them reasonably well tuned up. With a fully developed engine such tuning up does not require a great amount of time by a good mechanic.

Before proceeding further it is necessary to understand what is intended by maximum power. This involves at once the "rated speed" because power output means nothing unless it is obtained at a usable rotative speed of the propeller. Maximum power at rated speed is what we have to consider but the rated speed should certainly not exceed 85 per cent of the speed at which the power no longer increases with the speed.

If an engine is designed to mount the propeller directly on the crankshaft, we have another speed limiting feature. There is good reason to believe that wooden propellers will not give undue trouble if in the air the speed does not exceed 1200 r.p.m. but this is not always sufficient speed to show a good engine weight per horsepower. Metal propellers may partially solve the problem. The use of better wood or some composite material may allow the speed to be raised slightly.

It is impracticable to reduce the propeller speed so far as would be done if the only object were to increase efficiency because the diameter of the propeller increases beyond a desirable limit. Obviously with small powers the propeller speed may be cut away down but with the larger engines ground clearance must be maintained and at the best four-bladed propellers may be required. Gearing down the propeller allows its speed to be determined upon without necessarily affecting the crankshaft speed and the gearing loss may be made exceedingly slight.

Furthermore, should we not take advantage of the possible increase of power with speed up to a certain point? It is usually true that the average well designed airplane engine intended for operation somewhere between 1200 and 1400 r.p.m. may be operated with increasing power up to 1800 r.p.m. without overloading bearings or getting into any incurable difficulties. But such a speed is not practical unless the propeller is geared down. Nevertheless, a direct drive airplane engine is brought out now and then with four valves per cylinder, a complication which is hardly worth while under 2500 r.p.m.

There is a question as to whether engine rating should be based on the maximum power with an overrich mixture or on that developed with highest efficiency. On the whole, it would seem best to take the power obtainable with a thirty-inch barometer and with a mixture midway between the maximum power and minimum consumption points. It is to be remembered that with increasing altitude or dropping barometer the mixture becomes richer, hence the mean value of both barometer and richness is desirable.

As a summary suggestion why not consider the rating of airplane engines as follows: Ninety-five per cent of the average maximum power of three well tuned production engines with thirty-inch barometer, mean mixture adjustment as described above and at a definite practical propeller speed, such as 1200 r.p.m.?

THE FLYING MACHINE FROM AN ENGINEERING STANDPOINT

By F. W. Lanchester. D. Van Nostrand.

This, Mr. Lanchester's latest volume, is a reprint of the James Forrest Lecture for 1914, with the addition of a discussion concerning the theory of sustentation and the expenditure of power in flight, the latter having been presented to the International Engineering Congress in San Francisco in 1915. The range of territory covered is enormous, and the treatment of each topic is necessarily a little brief, the author aiming to give an outline of his own original conceptions and theories, rather than to cover the whole field, or any part of it, very completely.

The chapters on catastrophic instability and stability and control, too, are worthy of special mention.

Course in Aerodynamics and Airplane Design

By Alexander Klemin, A.C.G.I., B.Sc., S.M.

Instructor in Aeronautics Massachusetts Institute of Technology, Member of the Aeronautical Society of Great Britain and Ireland,

and

T. H. Huff, S.B.

Instructor in Aeronautics, Massachusetts Institute of Technology

Copyright, 1917, by A. Klemin. All Rights Reserved.

PART II—SECTION 9

Type Sketches of Secondary Training Machine—General Principles of Body Design

In Fig. 1 are shown three views of a secondary training machine, very similar to the JN-2, and in accordance with our figures of *Section 7*.

A few modifications have been made in the process of drawing up the machine from the figures given in *Section 7*. The figures there were derived from empirical formulas, but in the present stage of the art it cannot be too strongly insisted that no empirical formulas hold with absolute rigidity, and that "eyeability" is almost as important—except in the case of the stabilizer and elevator, on which more data is available. Thus the rudder has been reduced in area from 12 to 10 sq. ft., and the vertical fin from 4 to 3.5 sq. ft.

The stabilizer and elevator have been left unchanged. In drawing the plan view of the machine, modifications were also found necessary in the ailerons. The original scheme was to place the ailerons on the top plane only. But in order to secure the necessary area it was necessary, with the spar position selected, to make the ailerons very long and bring them in comparatively close to the body (with an overhang on the top plane this difficulty would not have occurred), and ailerons brought in close to the body have an insufficient leverage for part of their surface. The better plan seemed to be, therefore, to place the ailerons on both surfaces. Their area was also slightly increased, from 38 to 42 sq. ft. total area.

It must be insisted upon again that this machine is not a perfect specimen of its type. For instance, had an overhang been employed as on the JN-4, the aileron area of 35 sq. ft., with its greater lever arm, would have been amply sufficient. Also the outer strut would have been almost at the mid point of the aileron, thus permitting the use of a single aileron post; whereas in the present case we are obliged to use two aileron posts.

Another poor point is that the tail skid abuts directly on the rudder post. The control surfaces should never be so placed as to sustain injury by an abrupt landing, as might be the case in this arrangement.

A drag wire is shown carried from the top of the inner strut to the engine. This helps to keep the body from twisting under the effect of gyroscopic forces on the engine, and also to relieve the drag bracing. Nevertheless, in computing the drag bracing the effects of such a wire are totally neglected.

General Requirements in Body Design

These may be very briefly summarized:

(1) Stream-Line Form

The power plant and personnel must be enclosed in a form approximately stream-lined. The general shape of the body is largely determined by the size and shape of the engine selected. For the vertical six-cylinder engine the body may be narrow and deep. For a V cylinder engine, a wider but shallower body is advisable, and with a rotary engine a body of very large maximum diameter. But consistent with structural and other considerations, a body should be selected which gives minimum aerodynamic resistance. The best form of body would, of course, be symmetrical about an axis. Some data for the resistance of airplane bodies has been given in the first part of the Course, but there is no doubt that considerable improvement is possible in this direction, possibly by employment of monocoque construction. Where a four girder body is used, and attempts are made to secure stream-line form, the designer must guard against excess weight.

(2) Fin Area of Body

A flat bottomed body may be very helpful in securing longitudinal dynamic stability. A body with flat sides has to be handled carefully. It is equivalent to a long fin, with most of the fin area aft of the center of gravity, and this tends to head a machine into the wind—an advantage if the effect is not excessive. Such fin area is, however, best secured by the use of a vertical fixed fin. With a large flat sided body, it is as well to investigate yawing moments in the wind tunnel. One of the reasons why totally enclosed bodies have not come into use is that with their large fin areas, they have a tendency to spinning.

(3) Length of Body

Apart from the necessary length of body to give sufficient arm to the tail surfaces, it is important that the tail surfaces should be far enough away from the wing so that the wash of the wings should not affect them too much.

(4) Provision for Pilot and Passenger

The necessary requirements are obvious. To protect the face of the passenger, a transparent lip is generally fitted on the front edge to deflect the air upwards. The back of the pilot's head may be stream-lined with a suitable projection. Specification 1002 gives standard arrangements for pilot's and passenger's seats.

(5) Engine Installation

Should be readily accessible and cowling easily removable.

(6) Gasoline Tanks

Should be near the center of gravity of the whole machine, so as to disturb balance as little as possible as fuel is consumed. Where it is impossible to place the fuel supply directly over the center of gravity, the gasoline and oil may be made to balance one another approximately.

(7) Engine Foundation

Must be rugged to prevent loosening up of the bolts by vibration, transmission of the torque of the engine to the body, and breaking loose in a bad landing. Nevertheless, the foundation should be flexible enough so that slight engine vibration is easily taken up. The following example will illustrate the forces on the foundation bolts due to engine torque:

Six cylinder 120 h.p. 1200 r.p.m. Torque $= \frac{120 \times 550}{2\pi \times 20} = 525$,

then if F is force on either side, $2F \times .575 = 525$, where .575 is half the distance between engine bed bolts, and the force on either side is 457 lb.

(8) Engine Must Be Secured Against Weaving

When the airplane pitches, there is a tendency owing to gyroscopic action of the propeller, for the engine to "weave" either to right or left. Diagonal members in the plane of the engine bearers as well as wires are often used. The ideal engine foundation would seem to be of pyramidal form.

(9) Strength of Body

The body must be strong enough to withstand (a) air loads due to tail surfaces, (b) dynamic loads in the air, (c) loads on landing.

These are but a few of the requirements in body design. Numberless points arise in detail work, in which experience and care, and not general rules, are necessary.

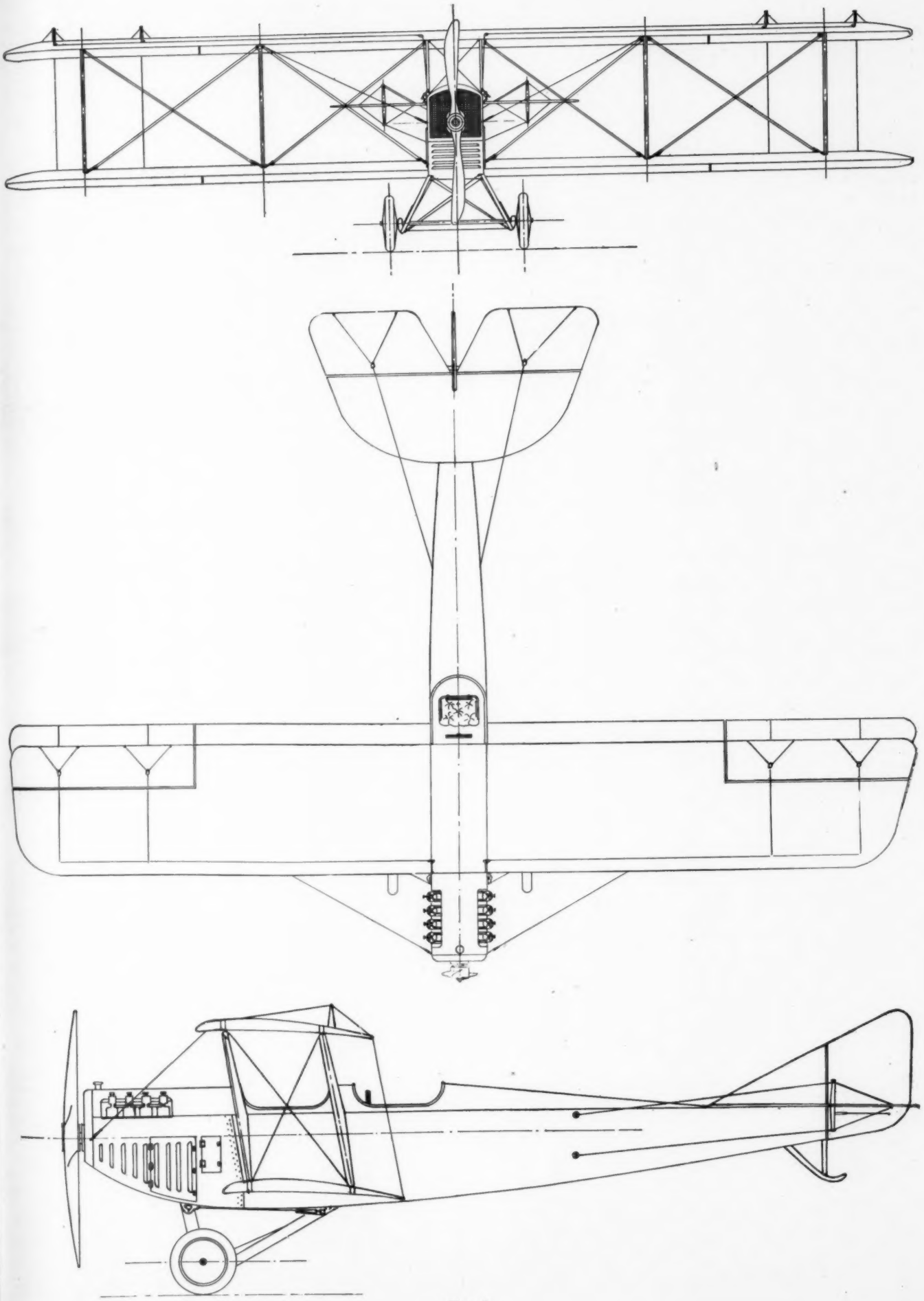


FIG. 1

Formulas for Spruce Compression Members

The most reliable data on spruce struts—the material in which we are most interested—is given in Dr. Hunsaker's note to which reference is appended. Experiments were carried out on Maine white spruce, West Virginia white spruce, and Oregon red spruce. Values varied so much for each specimen that it would be unsafe to use them definitely for wood of varied origin, of varied position in the log, and degree of seasoning, and in actual construction tests on specimens are always necessary.

In these experiments, the modulus of elasticity found by observing deflection under loading was found to be 1,825,000 pounds per square inch. Two formulas for crippling stress, defined as the crippling load divided by the area of cross section in square inches, were deduced.

(1) For long struts $\frac{L}{K} > 70$ $\frac{P}{A} = \frac{8.72\,E}{\left(\frac{L}{K}\right)^2}$ where P = crippling load A = area in square inches L = length in inches K = least radius of gyration in inches E = modulus of elasticity in pounds per square inch. (Some designers employ the ordinary Euler's formula, $\frac{P}{A} = \frac{\pi^2 E}{\left(\frac{K}{L}\right)^2}$ using a value of $E = 1{,}600{,}000$.)

(2) For short struts $\frac{L}{K} < 70$ $\frac{P}{A} = 6500 - 46.5\,\frac{L}{K}$ × (Some designers employ a modification of Rankine's formula: $P = \frac{A\,fe}{1+\phi}\left(\frac{L}{K}\right)^2$ where fe = 8,000 lbs. for spruce, E = 1,600,000, $\phi = \frac{fe}{\pi^2 E}$.)

By careful selection of spruce the crippling loads given by the above formulas can be easily secured. It was formerly customary to use a material factor of safety of 2 for the wing struts, and 1½ for body struts.

There arises a further difficulty in connection with the above formulas, in determining whether a strut is fixed or hinged at the ends. It is usually assumed that

(1) wing struts with pin joint fastenings are hinged at either end.
(2) wing struts with socket fastenings of usual type are considered as being fixed at one end, and round at the other.
(3) body longitudinals, continuous over joints, are taken as fixed at ends.
(4) body horizontal and upright struts are taken as fixed at one end and hinged at the other.

For a strut fixed at one end, and hinged at the other, the equivalent length becomes $\frac{L}{\sqrt{2}}$, for a strut fixed at both ends, the equivalent length becomes $\frac{L}{2}$. Thus the above formulas become:

(1) Ends hinged $\frac{P}{A} = \frac{8.72\,E}{\left(\frac{L}{K}\right)^2}$ $\frac{P}{A} = 6500 - 46.5\,\frac{L}{K}$

(2) One end fixed one hinged $\frac{P}{A} = \frac{8.72\,E}{\frac{1}{2}\left(\frac{L}{K}\right)^2}$ $\frac{P}{A} = 6500 - \frac{46.5\,L}{\sqrt{2K}}$

(3) Both ends fixed $\frac{P}{A} = \frac{8.72\,E}{\frac{1}{2}\left(\frac{L}{K}\right)^2}$ $\frac{P}{A} = 6500 - \frac{46.5\,L}{2K}$

Body Stress Diagrams

Body stress diagrams are still on a somewhat unsatisfactory basis, and a number of different methods are adopted. Although the longerons of a body are continuous, and the cross bracing members more or less fixed, stress diagrams are always drawn as if it were entirely a pin-jointed structure. Subsequently, compression members are treated as either wholly or partly fixed at the ends. This is inconsistent but probably all that can be done, without very lengthy refinements.

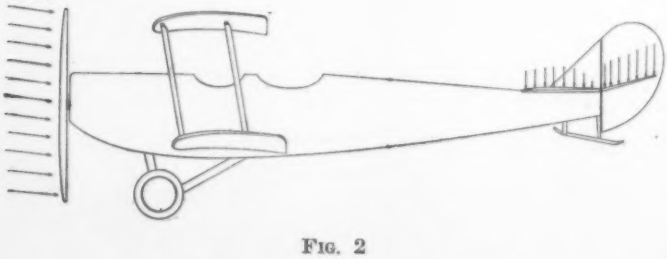


FIG. 2

Factors of safety have been specified in a number of ways, of which we have noted some already.

Army Specifications 1000, 1001 and 1002

Air speed, 100 miles an hour. Angles of incidence of fixed horizontal tail surface, minus 6 deg.; elevator surface, minus 20 deg. Factor of safety not less than 2.5. This is based on the forces met with when the machine is violently righted after a rapid dive. It takes care solely of the air loads due to tail surfaces. When in the air the body is supported at the hinges of the wings, and the air loads are not transmitted to the part of the body forward of the hinge pins. It can be seen that this is by no means an ideal specification. It has also been criticized on the ground that no pilot can, under ordinary conditions, exert sufficient force to move the elevator to such a position.

Army Specification 1003

Body forward of the cockpit shall be designed for a factor of safety of ten (10) over static loading conditions with the propeller axis horizontal. Body in the rear of cockpit shall be designed to fail under loads not less than those imposed under the following conditions:

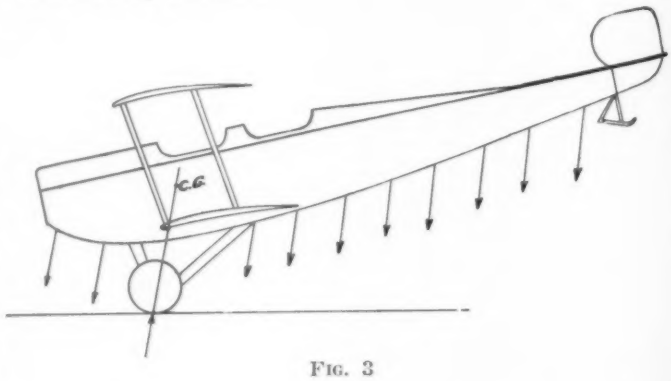


FIG. 3

(a) Dynamic loading of 5 as the result of quick turns in pulling out of a dive; (b) superposed on the above dynamic loading shall be the load which it is possible to impose upon the elevators, computed by the following formulas: $L = .005AV^2$ where A is the total area of the stabilizing surfaces, i.e. elevators and fixed horizontal surface, and V is the horizontal high speed of the airplane. The units are kilograms, square meters, kilometers per hour; (c) superposed on this loading shall be the force in the control cables producing compression in the longerons.

This specification is sounder than the previous one. It imposes the air load on the rear part of the body, which is as it should be, and provides a sufficient dynamic loading for the forward part of the machine.

Another Suggested Method

In the author's opinion, the stress diagrams should be even more complete. They should include calculations (a) carried through on the air loads, (b) calculations carried through on the landing loads, specifying some landing speed, a gliding angle, and travel of shock absorber.

A Detailed Example of Stress Diagram

In Fig. 2, is shown the skeleton framework of a JN-2 body, which fits in with our design of a standard airplane body. In accordance with the preceding paragraph, we should draw two diagrams for it:

(1) With the body and tail surfaces in position shown in Fig. 2, horizontal tail surface at minus 6 deg., elevator surface at minus 20 deg. The air loads on these surfaces can be computed as follows: Lacking precise experimental data, we may assume that in the worst possible case, the pressure on the tail = $.0026AV^2$ area of stabilizer and elevator = 50 sq. ft. V, the highest speed attainable during a dive, may be

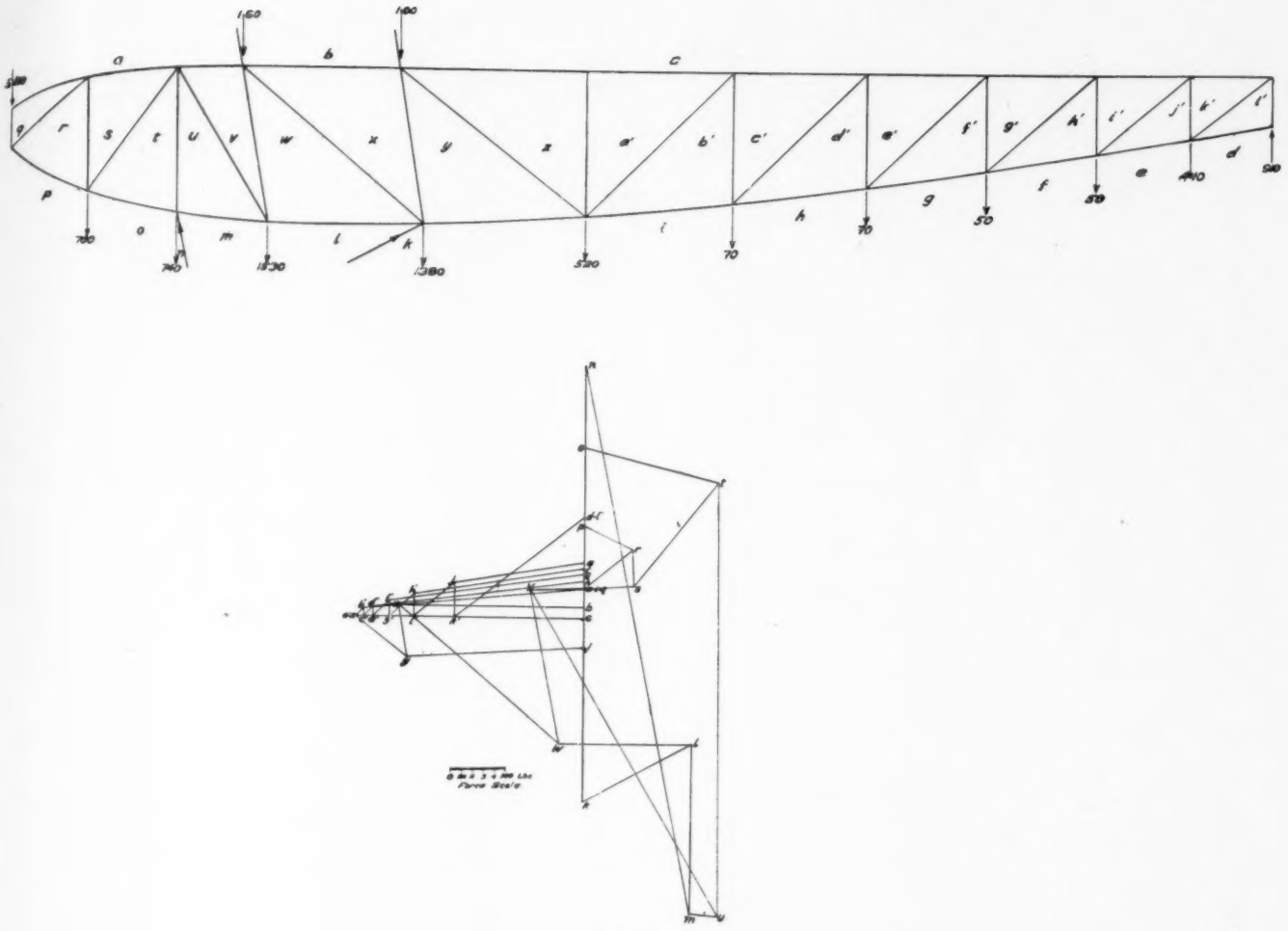


FIG. 4

taken as 100 m.p.h. F, the tail load, then equals $.0026 \times 50 \times (100)^2 = 1300$ lb.

With these air loads computed, a stress diagram can be easily drawn as for a simple cantilever with supports at the rear body hinges. As an article in AVIATION and AERONAUTICAL ENGINEERING for March 1 1917 shows, the stresses obtained in this way are in certain members smaller, in other members larger, than those obtained from the landing diagram.

(2) The stress diagram on the assumption of the landing shock leaves room for much discussion. The difficulty arises primarily from the fact that it is difficult to say what the worst landing conditions before breaking are for which a machine should be designed. Also it is extremely difficult to include all the forces in play, which may include (a) lift on the wings, (b) drag on wings and body, (c) lift and drag on the tail surfaces, (d) the reaction perpendicular to the ground, (e) tractive resistance on the wheels.

Further difficulties arise from the fact that the center of the wheels does not lie under the center of gravity of the whole machine, so that if a dynamic load is applied vertically at the wheels, the weight applied at the center of gravity gives a turning moment which must be balanced in some way or another. Two methods are suggested which seem fairly reasonable, and provide a rational method of computation. In the first method, it is assumed that the machine is gliding on a path of say 1 in 7, and hits the ground nose heavy. In such a case as can be seen from Fig. 3 the reaction of the ground may be assumed to pass through the center of gravity of the machine, and a balance of forces is obtained. The dynamic load in such a case may be obtained on lines indicated in a previous section on chassis design.

In the second method, the pilot is assumed to flatten out from the glide, and then turn up to a big angle and pancake down, with the wheels and skid striking the ground simultaneously. In such a case, it is very difficult to compute the dynamic load, but a balanced system of forces is readily obtained, distributing the load between the wheels and the skids as shown in Fig. 4. The dynamic load factor there is taken as 8. In Table 1 are tabulated the stresses in various members. In the ensuing sections, dimensions will be allotted to such members.

TABLE I

BODY STRESSES

		Longerons	
ag	0	pr	490 C.
as	460 T.	ot	1250 C.
av	490 C.	mu	260 C.
bx	1680 C.	lw	1200 T.
cz	2070 C.	jy	1600 T.
ca′	2070 C.	ib′	2000 T.
cc′	1990 C.	hd′	1920 T.
ce′	1910 C.	gf′	1780 T.
cg′	1770 C.	fh′	1550 T.
ci′	1540 C.	ej′	1180 T.
ck′	1170 C.	dl′	0
		Struts	
pg	560 C.	b′c′	70 C.
rs	330 C.	d′e′	90 C.
tu	3900 C.	f′g′	140 C.
vw	1410 C.	h′i′	210 C.
xy	470 C.	j′k′	310 C.
za′	0	l′c	910 C.
		Wires	
gr	570 T.	c′d′	120 T.
st	1200 T.	e′f′	210 T.
uv	3400 T.	g′h′	300 T.
wx	1910 T.	i′j′	480 T.
yz	590 T.	k′l′	1470 T.
a′b′	100 T.		

References, Part 2, Section 9

"Notes sur la Construction des Aéroplanes," by P. James; *Revue Generale de l'Aeronautique Militaire*, March, 1914.

"Spruce Aeroplane struts under Compression," by J. C. Hunsaker; *Aerial Age*, August 16, 1916.

Revised Strength Figures for Wires and Cables

The following revised figures for wires and cables have been issued by John A. Roebling's Sons Co., and will supplement the table given in *Part* 2, *Section* 5 of the Course.

ROEBLING TINNED AIRCRAFT WIRE

American gauge (B&S) Number	Diameter, in.	Minimum breaking strength, lb.	Weight lb. per 100 ft.
8	.128	3000	4.40
9	.114	2500	3.50
10	.102	2000	2.77
11	.091	1620	2.20
12	.081	1300	1.744
13	.072	1040	1.383
14	.064	830	1.097
15	.057	660	.870
16	.051	540	.690
17	.045	425	.547
18	.040	340	.434
19	.036	280	.344
20	.032	225	.273
21	.028	175	.216

ROEBLING 19-WIRE GALVANIZED AIRCRAFT STRAND

Diameter of strand, in.	Breaking strength of strand, lb.	Approximate weight, lb. per 100 ft.
5/16	12,500	20.65
1/4	8,000	13.50
7/32	6,100	10.00
3/16	4,600	7.70
5/32	3,200	5.50
1/8	2,100	3.50
7/64	1,600	2.60
3/32	1,100	1.75
5/64	780	1.21
1/16	500	.78
1/32 7 wire	185	.30

ROEBLING 6 x 7 (COTTON CENTER) GALVANIZED AIRCRAFT CORD

Diameter of cord, in.	Breaking strength of cord, lb.	Approximate weight, lb. per 100 ft.
5/16	7,900	15.00
1/4	5,000	9.50
7/32	4,000	7.43
3/16	2,750	5.30
5/32	2,200	4.20
1/8	1,150	2.20
7/64	830	1.50
3/32	780	1.30
5/64	480	.83
1/16	400	.73

ROEBLING 7 x 7 (WIRE CENTER) GALVANIZED AIRCRAFT CORD

Diameter of cord, in.	Breaking strength of cord, lb.	Approximate weight, lb. per 100 ft.
5/16	9,200	16.70
1/4	5,800	10.50
7/32	4,600	8.30
3/16	3,200	5.80
5/32	2,600	4.67
1/8	1,350	2.45
7/64	970	1.75
3/32	920	1.45
5/64	550	.93
1/16	485	.81

ROEBLING 7 x 19 TINNED AIRCRAFT CORD

Diameter of cord, in.	Breaking strength of cord, lb.	Approximate weight, lb. per 100 ft.
3/8	14,400	26.45
11/32	12,500	22.53
5/16	9,800	17.71
9/32	8,000	14.56
1/4	7,000	12.00
7/32	5,600	9.50
3/16	4,200	6.47
5/32	2,800	4.44
1/8	2,000	2.88

Statoscopes

One of the most useful instruments in ballooning and dirigible work is the statoscope, employed to indicate very slight variations of altitude. It may be interesting to set forth the principles of operation of two standard forms in common use.

One made by Gradenwitz in Germany is described in Hildebrandt's "Airships, Past and Present." "It is contained in a metal case somewhat similar to that of a watch. Beneath the face is a circular opening, into which a tightly stretched rubber membrane is fitted, and a small rubber tube communicates with the inside of the case. If now the rubber tube is pinched, the outer air can no longer freely reach the inside of the case. Supposing a balloon or airplane to be ascending, the air enclosed within the statoscope will, therefore, expand, in consequence of the reduced external pressure; if it is descending, the opposite effect will take place. The contraction or expansion of the enclosed air reacts on the rubber membrane, which will be sucked inwards during a descent, and blown outwards if the balloon is rising. The movements of the membrane are communicated by very delicate wheelwork to a pointer on the face of the case, which, therefore, shows at a glance whether a rising or falling movement is in progress."

The Gradenwitz instrument is very sensitive, and much better as an indicator of rising or falling motion than the sluggish barometer. It has the disadvantage of requiring some little attention to get a reading, the pinching of the tube as mentioned above.

The Custer statoscope, according to a pamphlet supplied by manufacturer, obviates this disadvantage and is sensitive within a few inches vertical motion.

The instrument in its simplest form is a glass capillary tube attached to an enclosed reservoir at one end and opening to the atmosphere at the other end. A drop of oil in the tube seals the air within the reservoir. Any extremely small variation in the external atmospheric pressure will immediately be indicated by a motion of the oil one way or the other in tending to equalize the pressure within the reservoir and without. It can easily be seen that by elevating the instrument, the atmospheric pressure now being reduced outside the reservoir in comparison with that within, the bubble will move toward the open end of the tube. This motion of the oil is so sensitive to slight changes of atmospheric pressure that the motion can easily be detected by the naked eye of a change of vertical elevation of one inch of the instrument. Due to this extreme sensitiveness, it will be seen that any great elevation of the instrument will result in the bubble reaching the end of the tube very quickly. To overcome this, the tube is enlarged at each end, and the bubble breaks and forms over again, making the operation continuous.

To make the instrument "fool proof," a trap is included in each end of the tube, so that the oil will not escape in any position in which the instrument might be held. The entire instrument is enclosed inside of non-conducting material, so that sudden temperature changes will not materially affect the reading.

Aeronautical Patents

Copies of these patents may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED MAY 22, 1917.

1,227,319. Filed March 20, 1917. To Leon C. Robbins, Loveland, Col. Toy Airplane.

1,227,344. Filed Feb. 21, 1917. To Kaja P. Togstad, Maddock, N. D. Safety parachute for aviators.

1,227,464. Filed April 11, 1913. To Ira Emmett McCabe, Lexington, Neb. Aeronautics.

ISSUED MAY 29, 1917.

1,228,281. Filed Sept. 22, 1915. To Clarence Barrett, Salt Lake City, Utah, assignor, by direct and mesne assignments, of one-third to George Morrow and one-third to Robert W. Salisbury, Salt Lake City, Utah. Aerial torpedo.

1,228,381. Filed June 7, 1915. To Glenn H. Curtiss, Buffalo, N. Y., assignor to The Curtiss Motor Company, Hammondsport, N. Y., a corporation of New York. Hydro-Aero machine.

1,228,159. Filed Dec. 24, 1915. To Israel I. Ziperstein, New York, and Abraham C. Kaplan, Brooklyn, N. Y., assignors of fifteen one hundredths to Nathan Schreiber, fifteen one-hundredths to Aaron Schreiber, fifteen one-hundredths to Benjamin Kaiser, and five one-hundredths to Benjamin Oppenheim, New York, N. Y., and one thirty-second to Kate Zucker, Chicago, Ill. Airship.

1,227,912. Filed Nov. 17, 1916. To Martin Jelalian, Cranston, R. I. Combined dirigible and hydro-aeroplane.

1,227,937. Filed March 31, 1916. To Adolf Frank Russ, Pittsburgh, Pa. Airplane.

1,228,383. Filed July 14, 1915. To Glenn H. Curtiss, Buffalo, N. Y., assignor to The Curtiss Motor Co., Hammondsport, N. Y., a corporation of New York. Flying machine.

1,228,054. Filed Aug. 19, 1914. To Charles Lemuel Sanford, Washington, Pa., assignor to Sanford Manufacturing Co., Washington, Pa. Flying machine.

1,228,227. Filed Dec. 18, 1916. To Alex Melniczak, Camden, N. J. Airplane.

1,228,380. Filed Feb. 18, 1914. To Glenn H. Curtiss, Hammondsport, N. Y., assignor to The Curtiss Motor Co., Hammondsport, N. Y., a corporation of New York. Method and system for operating rudders of aircraft.

1,228,375. Filed Sept. 18, 1915. To John P. Tarbox and Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Airplane & Motor Corporation, a corporation of New York. Universal wing-pose socket.

ISSUED JUNE 5, 1917.

1,228,390. Filed Feb. 1, 1916. To Louis Béchereau, Paris, France, assignor to The Society Spad Societé Anonyme pour l'Aviation et ses Derivés. Airplane.

1,228,705. Filed March 6, 1911. To Osam Shudow, San Francisco, Cal. Airplane.

1,228,729. Filed Sept. 15, 1916. To William Frances Williams, Leadwood, Mo. Airplane.

1,229,114. Filed June 2, 1916. To Frederick A. Meug and Lee C. Schrader, Flint, Mich. Flying machine.

Observations on Physical Effects of Flying

By Dr. Harry L. Schurmeier

The year and a half during which I was constantly associated with flying at the aerodrome at North Island, San Diego, California gave me ample opportunity to observe the physical status of the fliers. Two things must be discounted in considering this matter; first the equable climate of San Diego and second, the excellent physical and nervous stamina of the men. Regarding the former, San Diego presents practically the same climate as southern Italy, in consequence the diseases of more rigorous climates are rarely seen there.

The men are chosen from the Army at large, practically every corps being represented with the exception of the Medical Corps. The applicants are subjected to a most strenuous physical examination in which not only the general physical and nervous system is considered but also the temperament. Men showing marked nervous tendencies are frequently turned down. Special attention is given to the vision and to the organs of equilibrium, as any defect in the latter would obviously unfit a man for service.

So it may readily be seen that men subjected to so careful a selective process and living in such an equable climate would have fewer physical ailments than aviators in general. From my observations, I came to the conclusion that the effects of flying on the individual are evidenced chiefly on the nervous system and on the general health indirectly, through the nervous system.

One of the main barometrics of fluctuations in the status of a healthy individual nervous tone, is the blood pressure. The blood pressure as studied clinically is represented by millimeters of mercury contained in a glass tube. The pressure is taken by placing a cuff around the upper arm and inflating it with air until the pulse below the cuff is no longer perceptible. This point indicates the amount of pressure which it takes to obliterate the pulse and equals the pressure in the artery. The inflated cuff is connected with the mercury tube upon which the readings are registered.

Fluctuations in the pressure are attributed partially to the amount of adrenalin secreted in the blood. This substance is elaborated by two small glands lying just above the kidney. Variations in the emotions give rise to variations in the secretion of adrenalin and consequent changes in the pressure. For instance, fear, excessive fatigue, or increased nervous tension, all tend to raise blood pressure.

BLOOD PRESSURE EXPERIMENTS

The blood pressure experiments were carried out as follows: Certain men, some twenty in all, were selected, and their blood pressures taken daily, immediately before and after each flight. The experiments were carried out over a period of six weeks. It was not found feasible to make these observations in the air on account of the noise and vibrations of the machines. As a result of these experiments it was found that the mean general average of blood pressure compared very favorably with the normal for that age.

It was the comparative readings before and after flight, which were of interest. These readings were shown to be definitely higher in nearly every case immediately before flying. The few exceptions to this rule were in men showing marked nervous fatigue or to whom some disagreeable incident had occurred while in the air. In these men the blood pressure was higher on returning to the ground and remained so for several hours afterwards.

These findings are attributed to the fact that the moderate excitement attending the anticipation of flight, combined with the naturally increased mental and nervous activity, caused the raise in blood pressure. On finishing the flight the immediate nervous relaxation is shown by the drop in pressure. The differences in the readings occurring before and after flight were more marked in the newer fliers when first placed under instruction, showing their increased nervous tension at that time. The older and more experienced aviators showed scarcely any variations in pressure readings before and after flight, and their general average was lower than the newer men. The records showed no fluctuation of sufficient degree to be suggestive of anything pathological, merely accentuating the fact of the increased nervous strain, to which the aviator is at all times subjected, and showing the gradual adaptation of the individual to this strain.

Occasionally men complained of feeling stale, tired, and not up to the mark. This was ordinarily due to late hours, need of a vacation, or lack of stamina on the part of the individual. Irritability on the part of some of the instructors was quite marked at times. Their work is unquestionably very trying and their number of hours in the air greater than the others.

EFFECT OF ALTITUDE FLIGHTS

Regarding altitudes and the physical effect on the flier, it might be noted here that the mean atmospheric pressure at sea level will balance a column of mercury 30 inches high and that in ascending there is a direct fall in pressure of about one inch in mercury to every thousand feet ascended. The relative proportion of the constituent gases of the atmosphere remains the same with the exception of the watery vapors, which are confined to the lower levels. As the aviator ascends the tension of the gases in the bodily fluids balances that of the surrounding air. Obviously the quantity of oxygen per cubic foot of air becomes progressively less as the pressure decreases, and there is a drop in the arterial blood pressure of the flier.

The latter factor is, in a healthy adult, slight, and of minimum importance up to 6,500 feet; above this altitude the blood pressure drops more rapidly. In older men with some hardening of the arteries, there is a much more decided drop in pressure, which change is evidenced by slight headache, dizziness and ringing in the ears. This fact may be noted any day in crossing the mountains in a railway train; if the portly, florid man is questioned he will acknowledge these symptoms, which are largely due to lack of elasticity of the arteries and consequently inability on the part of the arteries to contract and establish rapid equilibrium between the arterial pressure and the lowered atmospheric pressure.

As has been previously stated, the watery vapors are confined to the lower strata, and as these are instrumental in retaining the heat of the sun's rays, the atmosphere becomes cooler as one ascends. It will thus be seen that in making altitude flights, three main factors must be considered; first, there is less oxygen to breathe; second, the arterial blood pressure is less, and last, there is a decided drop in temperature. Some very interesting and valuable data has been gathered at various times both in this country and abroad in regard to the effects of altitudes on the individual; these experiments have been carried out on the peaks of high mountains. It has in the first place been shown that among mountain climbers much more energy is expended by the untrained than by the trained climber; further, that men living at high altitudes develop more iron and red blood cells in the body. This variation has been shown to be from approximately 5 million red blood cells per cubic millimeter of blood, at sea level; to 8 million at 14,000 feet. The hemoglobin, the iron constituent of the blood cell whose function is to carry the oxygen from the lungs to the body cells, is increased from 20 to 30 per cent.

SCARCITY OF OXYGEN MAY CAUSE SICKNESS

The reason for this can readily be seen; the amount of oxygen per cubic foot of air is much less at high altitudes, the bodily oxygen demand remains constant, therefore, any sudden muscular activity would bring the margin of oxygen safety down to the danger zone. In consequence nature compensates by giving the blood more oxygen carrying and storing elements so that in case of any excessive exertion the body would have an adequate supply of this very necessary gas. Altitudes have a tendency to increase the chest capacity, in this way increasing the oxygen intake.

Mountain sickness, a malady which is directly attributable to the scarcity of oxygen at the higher levels, occurs in Europe as low as 9,800 feet, in the United States as a rule at considerably higher points. The symptoms of this disease are a heavy oppressed feeling in the chest, difficult breathing, with nausea and vomiting. There is also mental depression accompanied by a blue congested appearance of the face. These symptoms are unquestionably accentuated and brought on at lower levels by the mountain climber, owing to the excessive physical effort in making the ascent. Sitting quietly in the body of an airplane we should not expect such severe symptoms, nor any difficulty at all at such low altitudes.

I have heard men complain of slight dizziness, and headache when flying at altitudes of between 12,000 and 16,000 feet. These symptoms were dispelled by inhaling deeply. Some men who have flown at high altitudes constantly over a long period of time, have developed a very definite susceptibility to the effect of altitudes. One of the most pronounced cases of this is that of Lieutenant Cowdin, an American in the French Flying Corps. Mr. Cowdin has won the Croix de Guerre, the Medaille Militaire, the Legion of Honor, and the War Cross. He has brought down 17 of the enemies' machines, but at the present time is unable to fly at an altitude of over 3,000 feet without experiencing most annoying palpitation of the heart, and difficult breathing. The more severe symptoms of altitude sickness are immediately relieved by inhaling a few whiffs of oxygen, or administering some cardiac stimulant.

The direct causative factor of this condition seems to be a definite weakening of the heart muscle owing to an inadequate supply of oxygen; this being supplied the heart immediately resumes its normal functioning. This all tends to emphasizes the value of training and the

need of excellent physical form for the aviator. It is suggested that men who are going out after altitude records should live in the higher mountain regions for a time so that the body will be in the best possible condition to meet the demands of the occasion. This not being practicable a small oxygen tank with an inhaler may be taken along. This procedure corresponds to the necessary carburetor adjustment which is accorded the airplane engine on these occasions.

PHYSIOLOGICAL EFFECT OF SMASH-UPS

Two distinct phenomena stand out vividly in my mind in connection with men who have been subjected to a smash of any severity. These are: first the immediate effects, and second, the more remote after-effects. I have seen men pulled out of wrecked machines after a 50-foot fall or a bad side slip, suffering from extreme shock, as evidenced by weak pulse, cold skin, and pallor with either an active delirium or a stupor. This is much akin to the condition known as shell shock, so many cases of which have been reported in the present war in which a shell bursts near but does not hit the man. These men may recover and come back and fly as well as ever; on the other hand, I have known men who were only moderately shocked at the time of the accident, but who later developed vague nervous symptoms which persisted for months and incapacitated them for work of any kind. Some of these men are forever afterward machine shy. I remember one aviator who had a slight mishap; on landing, the machine was turned over, but no one was hurt. For a long time afterwards, this man consistently over-controlled and spoiled all his landings.

HYPNOTIC EFFECT CAUSES ACCIDENTS

Another rather interesting condition of less frequent occurrence is that in which the flier apparently experienced a lapse, or a period during which he remembers nothing and is unconscious of everything which has occurred. A few men have acknowledged to me that they have had such an experience. The most glaring of these lapses occurred to Herbert Latham, who at the time was flying an Antoinette monoplane, on Dominicus field in 1911. Latham came down on top of the grand stand and smashed his machine. He explained the affair by stating that at his last remembrance of anything he was flying level at an altitude of some 500 feet, the next thing he knew he was on top of the grand stand.

The general opinion seems to be that the monotonous drum of the propeller, combined with the entire removal from external stimulus has a hypnotic effect and that this effect is very much increased if the aviator looks steadily at the propeller. In other words he should keep interested in the passing show. Many accidents in which the aviator has lost his life, and which are of such a nature as to be entirely inexplicable, may be attributed to this cause. One of the main attributes of the stabilizer with its automatic control as demonstrated by Mr. Macy in his recent invention will undoubtedly tend to prevent accidents of this nature. It has been repeatedly demonstrated that a land machine will float for a time at least, if unfortunate enough to land in the water. The sad death of Lieutenant Gerstner in 1914 who endeavored to swim ashore after his machine had gone into the ocean, suggests the advisability of staying with the plane. His companion was saved after being kept afloat for several hours by holding on to the buoyant wings.

I have had the pleasure of knowing many fliers both among the civilian and the military aviators and I have tried to pick a type, a man whose entire physical and mental make up should enable him to perfect himself in the art of flying. My conclusions are that the type does not exist. I believe that the early training of athletics is invaluable as a preliminary for flying. Athletics give a man instant perception, quick judgment, with a rapid and facile coordination of the physical, all of which are very essential assets in the flying game.

Many of these intrepid pioneers of the air have lost their lives in this most hazardous but most fascinating of all sports. These losses should not be in vain; the cause of each fatality should be carefully determined, so that the mistakes will not be repeated. The American is a composite, and should lead in aviation; in him is combined the daring of the French with the ultra conservatism of the English and German, and there are certainly times when both of these factors are needed.

British Airplane Testing Methods

A general account of some of the methods of testing the performance of airplanes as practised by the testing squadron of the Royal Flying Corps was given recently in England by Capt. H. T. Tizard before the Aeronautical Society.

He stated that, so far as England is concerned, the general principles of the scientific testing of airplanes were first laid down at the royal aircraft factory. The methods of reduction adopted by the flying corps were based to a considerable extent on those of the R. A. F., with modifications jointly agreed upon; they have been still further modified since, and recently a joint discussion of the points at issue has led to the naval and military tests being coordinated, so that all official tests are now reduced to the same standard.

In order to reduce the results of a climbing test to standard atmosphere (i. e., the density of dry air at 760 mm. pressure and a temperature of 16 deg. Cent.) observations are required at intervals of the time from the start and of the height reached at those intervals. Here the difficulty arises that there is no instrument which records height with accuracy. The aneroid has faults partly unavoidable and partly due to those who first laid down the conditions of its manufacture. As now graduated it will give the correct height only if the atmosphere has a uniform temperature of 50 deg. Fahr. (10 deg. Cent.) from the ground upward.

Aneroid Observations

This temperature is much too high, and only on the hottest days in summer, and even then very rarely, will the average temperature between the ground and 20,800 ft. be as high at 50 deg. Fahr.. In winter or cold days the reading may be 2,000 ft. too high at 16,000 ft., the aneroid showing 16,000 ft. when the real height is only 14,000 ft. Hence a temperature correction must be applied, and on account of its magnitude it is important that observations of temperature should be made during every test. For this purpose a special thermometer is attached to a strut of the machine, well away from the body and clear of any warm air coming from the engine. If the temperature is noted at the same time as the aneroid reading, both the atmospheric pressure and temperature at the point are known, and the density can be calculated or read off from curves drawn for the purpose.

The observations necessary (after noting the gross airplane weight and the net or useful weight carried) are therefore (1) aneroid height every 1,000 ft,; (2) time from the start of the climb; and (3) temperature, with (4) air speed and (5) engine revolutions at frequent intervals. The observed times are then plotted on squared paper against the aneroid heights; and from the curve drawn through them the rate of climb at any part can be obtained (also in aneroid feet) by measuring the tangent to the curve at the point. This is done for every 1,000 ft. by aneroid, and the true rate of climb is then obtained by multiplying the aneroid rate by the correction factor corresponding to the observed temperature. The time rates are then plotted afresh against standard heights, and the curve gives the rates of climb corresponding to the standard heights of 1,000 ft., 2,000 ft., 3,000 ft., etc.

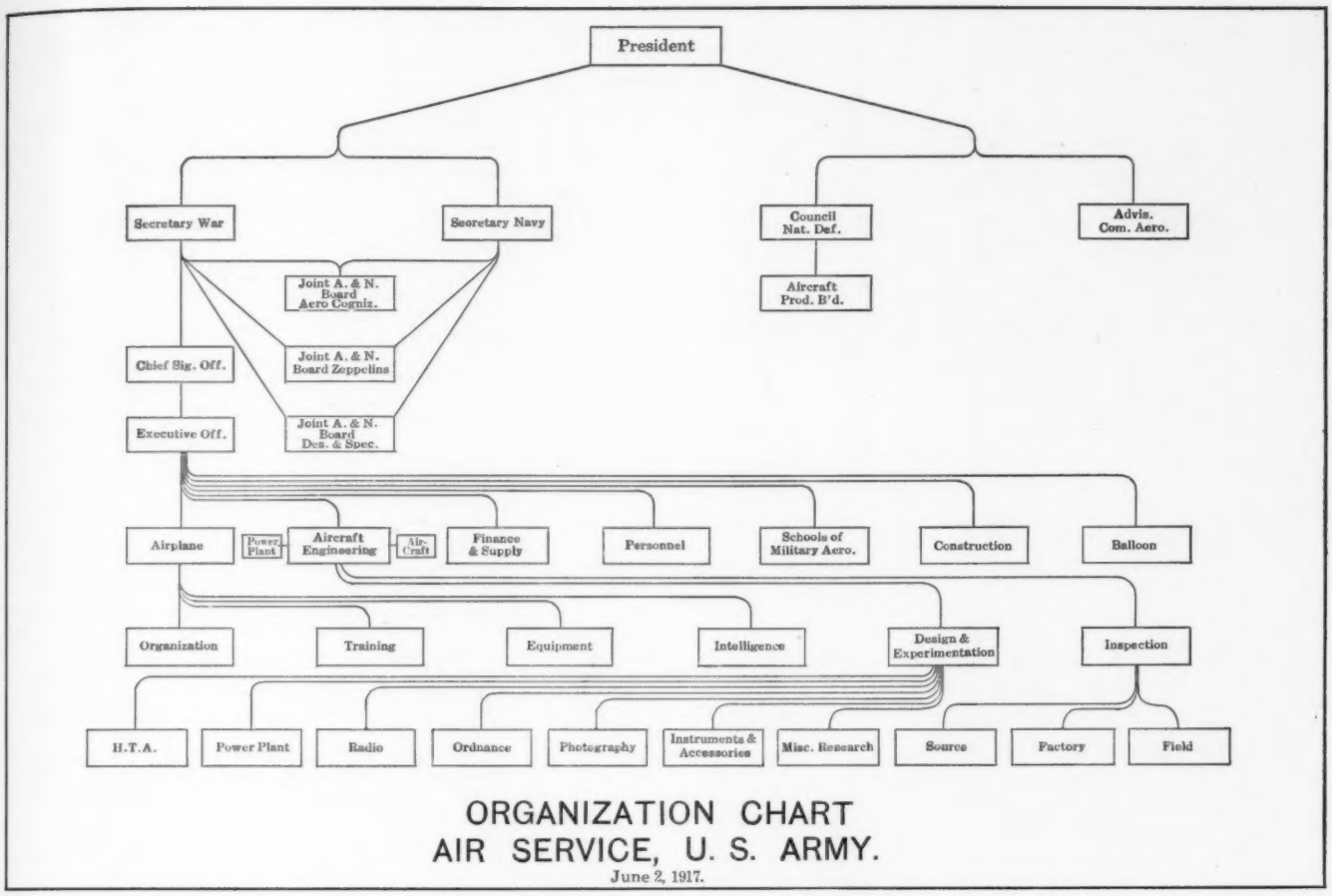
At least two climbing tests, and if time permits three or more, are made of every new machine up to 16,000 ft. or more by aneroid. The final results given are the official tests, and represent as closely as possible the performance on a standard day, with temperature effects, up and down currents, and other errors eliminated.

After reaching 16,000 ft. or whatever it is, the flyer's next duty is to measure the speed flying level by air-speed indicator at regular intervals of height (generally 2,000 ft.) from the highest point downwards. The air speed indicator reads too low at great heights, and its readings must be corrected by dividing by the square root of the density of the air. Even the corrected speeds will be true only if there are no disturbances due to the pressure head being in close proximity to struts or wings. Hence it is always necessary to calibrate the air speed meter, and the only way of doing this is to measure the real air speed by actual timed observations from the ground. One method is to use two camera-obscuras, one of which points vertically upwards and the other is set up sloping towards the vertical one. At one important testing center the cameras are a mile apart. But when a machine has to be tested quickly and low clouds or other causes prevent the camera test from being carried out, it becomes necessary to rely on measurement of speeds near the ground, the airplane being flown about ten feet off the ground and timed over a measured run by two observers, one at each end of the course.

U. S. Navy Aviators in France

The Navy Department has announced that the first regular American fighting force on French soil consists of naval aviators, who are to co-operate with the French Navy in meeting the submarine peril off the French coast, and also to aid the American aviation section on the Western battle front.

The aviators include Lieutenant Gratton O. Dichman and Lieutenant Kenneth Whiting and Junior Lieutenants Godfrey De C. Chevalier and Virgil C. Griffin. Many of the others already have made their mark in the United States navy aviation service.



ORGANIZATION CHART
AIR SERVICE, U. S. ARMY.
June 2, 1917.

Organizing Our Air Service

The above chart gives for the first time the organization and responsibility of our air service. It shows the channels through which the different committees, boards, and departments work and clears up for the aeronautical public a confusion which was the natural outcome of the quick expansion at the capital.

The National Advisory Committee for Aeronautics has issued a statement which makes clear its authorization, functions and financial support. In order to make plain its position the following statement to be followed by others by other boards is given:

"The National Advisory Committee for Aeronautics was authorized by Act of Congress approved March 3, 1915. The members were appointed by the President, and include representatives of the War and Navy Departments, also the Departments of the Treasury, Agriculture and Commerce, and the Smithsonian Institution; in other words, all of the departments interested in questions coming befor the Committee, with the exception of the Post Office Department, which is interested in the acquiring of the best machines for aerial mail service. Four technical members were appointed from without the Government service.

"The Advisory Committee, under appropriation by Congress, began its work at once, with a view to first, organizing the aeronautic industry into an association; second, clearing up the patent situation in relation to aeronautics, and third, getting the industry into line to provide for quantity production of aircraft.

"All of these results were brought about and on March 29, 1917, a communication was addressed to the Secretary of War and the Secretary of the Navy, and a copy transmitted to the Council of National Defense, recommending a continuing program for the production of aircraft.

"On April 10, 1917, the Advisory Committee recommended to the Council of National Defense that an Aircraft Production Board be appointed to take over the consideration of the various questions arising in connection with the production of aircraft and the training of aviators, both for governmental and civil purposes.

"Both of the above recommendations were approved and an Aircraft Production Board was appointed, with Mr. Howard E. Coffin as chairman.

"On November 25, 1916, the Advisory Committee recommended to the Secretary of Agriculture that a systematic survey of the atmosphere be undertaken by the Weather Bureau. This was approved by the Secretary of Agriculture, an estimate was submitted, and Congress has made an appropriation of $100,000 to begin the work.

"The Advisory Committee is now giving attention to the problems connected with the development of improved designs of aircraft, including examination of new inventions, and various lines of research work pertaining to the scientific and other problems incident to the development of aeronautics, and the question of insurance for aviators. Its function is quite different from that of the Aircraft Production Board, and it is an entirely independent organization, reporting directly to the Congress through the President. The authority for all proposals, specifications, and contracts for aircraft to be furnished to the Government rests with the War Department in the case of aircraft for the Army, and with the Navy Department in the case of aircraft for the Navy.

"The problems of the question of training of aviators, which includes the purchase of grounds, the erection of buildings, methods of training, etc., all come within the jurisdiction of the War and Navy Departments, respectively. Neither the Council of National Defense, nor the National Advisory Committee for Aeronautics, nor any governmental board or committee, has authority in the matter as far as the Government is concerned. The Government may contract with private organizations for the training of aviators if it desires to do so."

RULES AND REGULATIONS FOR THE CONDUCT OF THE WORK OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Approved by the President of the United States, June 14, 1915, in accordance with the provisions of an Act of Congress (Naval Appropriation Act, Public No. 271, 63d Congress) approved March 3, 1915.

Rules

The Committee may exercise all the functions authorized in the Act establishing an Advisory Committee for Aeronautics.

The Committee, under regulations to be established and fees to be fixed, shall exercise its functions for the military and civil departments of the Government of the United States, and also for any individual, firm, association, or corporation within the United States; provided, however, that such departmnt, individual, firm, association, or corporation shall defray the actual cost involved.

No funds shall be expended for the development of inventions, or for experimenting with inventions for the benefit of individuals or corporations.

Regulations for Conduct of Committee

Meetings

The annual meeting of the Advisory Committee shall be held in the City of Washington, in the District of Columbia, on the Thursday after the third Monday of October of each year. A semi-annual meeting of the Advisory Committee shall be held on the Thursday after the third Monday in April of each year, at the same place.

Special meetings of the Advisory Committee may be called by the Executive Committee, by notice served personally upon or by mail or telegraph to the usual address of each member at least five days prior to the meeting.

Special meetings shall, moreover, be called in the same manner by the Chairman upon the written request of five members of the Advisory Committee.

Officers

The officers of the Advisory Committee shall be a Chairman and a Secretary, who shall be elected by the Committee by ballot, to serve for one year.

The Chairman shall preside at all meetings of the Committee and shall have the usual powers of a presiding officer.

The Secretary shall issue notices of meetings of the Committee, record its transactions, and conduct the correspondence relating to the Committee and to the duties of his office.

Committees

There shall be an Executive Committee which shall consist of seven members, to be elected by the Advisory Committee by ballot from its membership, for one year. Any member elected to fill a vacancy shall serve for the remainder of his predecessor's term. The Executive Committee shall elect its Chairman.

The Aircraft Industry Is Prepared

By Benjamin L. Williams

Secretary Aircraft Manufacturers' Association

The American aircraft industry is in a position to meet the most liberal developments that can occur. Our factories are equipped and tooled up and employ about ten thousand men who are capable of turning out any quantity of at least five different types of airplanes and sea-planes, to meet any requirements that foreign experience has indicated during the past two years as being desirable. Many factories are now working on the relatively small orders that have been placed with them by this Government, and are anxiously awaiting the word to expand to a greater regree.

Earl Kitchener in the early part of the war, placed with the British aircraft constructors orders that were far beyond their ability to produce, and as a consequence, the industry had enough work ahead to enable it to make a decided advance.

In America the industry has orders that have been placed with them well in hand, and type for type, can equal the foreign built machines, although the constructors abroad have had the advantage of three years' intensive development, backed up by an exceedingly liberal encouragement from the Government.

The American industry, given the same amount of money and the same degree of encouragement, has the ability to overshadow even this great achievement, far beyond the highest expectations.

American ingenuity and commercial enterprise along practical lines is bound to win out, and with the asurance of continued orders for a definite period the individual manufacturers who now are representative of a well established industry, will give a most excellent account of themselves.

It is, however, essential that to enable the industry to map out a definite plan of action to meet the new conditions, the fullest possible support be given by all who are directly concerned.

Meeting of Aircraft Manufacturers' Association, Held June 13, 1917

The meeting was called to order by President Russell. The following members were in attendance:

Mr. Upperci, Aeromarine Plane & Motor Corp.
Mr. Russell, Burgess Company.
Mr. Tarbox, Curtiss Aeroplane & Motor Corp.
Mr. Flint, L-W-F Engineering Co.
Mr. Mingle, Standard Aero Corp.
Mr. Foss, Sturtevant Aeroplane Co.
Mr. Foss, B. F. Sturtevant Company.
Mr. Morse, Thomas-Morse Aircraft Corp.
Mr. Williams, Sec'y Aircraft Mfrs. Assoc.

An all day session was held, the morning being devoted to the reports of the various committees and the afternoon session to the regular business of the association.

The Patents Committee had before it many subjects relating to advanced ideas in the aeronautical art and some safety devices were submitted. From these devices a selection will be made as best suited to immediate requirements and the development work essential thereto put under way.

The Standardization Committee

The committee was named as the result of long and carefully considered deliberation and the A. M. A. has now determined to undertake the work of establishing its own standards for the aircraft industry in cooperation with the S. A. E. The entire technical talent of the manufacturers has been placed at the disposal of the Standardization Committee and it is the feeling of the A. M. A. that the ability of these men directed toward a common end will be productive of more successful results than could be obtained through the S. A. E. alone.

The S. A. E. will be invited to have representation on the A. M. A. Committee and appreciation is expressed for the good work done thus far for the aeronautical industry by their committees. It is proposed to proceed at once with the work on standardization of the sixteen subjects and the construction work will follow as rapidly as is essential to the expedition of the manufacture of aircraft in quantities.

These items are as follows:

1. Turnbuckles.
2. Eyebolts.
3. Shackles.
4. Bolts & nuts.
5. Propeller hubs.
6. Wire & cable ends.
7. Special light pipe fittings.
8. Flange & filler caps for gas & oil tanks.
9. Wheels & hubs.
10. Control pulleys.
11. Control arms.
12. Location of controls in cockpits.
13. Seats.
14. Strut sockets.
15. Strut ends.
16. Motor supports (on crank case).

Membership Committee

Orville Wright was elected an honorary member in recognition of his work as a pioneer in the aeronautical art.

Hall-Scott Co. was elected a manufacturing member with H. T. Whitaker as their representative. Communications were received from the Dayton-Wright Co. and the Wright-Martin Co.

The materials committee reported that the industry already had on hand at the factories, 4,000,000 feet of air dried spruce, suitable for airplane construction and 300,000 yards of Irish linen for wing and body covering, this being sufficient to produce 2,500 airplanes immediately.

The committee also reported that through the efforts of the Association, difficulties had been overcome in the transportation of materials and the delivery of finished products, from the allied trades. Through the association office an industrial director had been established, covering a field supplying raw materials and finished products to the aircraft industry.

The publicity committee reported that they are maintaining a press bureau and are acting on instructions from the Board of Directors. It will be the duty of the committee to correct all wrong impressions that appear in public print, relating to the manufacture of aircraft. Up to the present time there has been no source of authoritative information such as the Manufacturers Association now could supply. With the information now at hand, the Association is in a position to place before the public the true facts relating to the ability of the aircraft industry to meet the requirements of the Government.

Advisory Committee

A letter was received and read from Mr. Howard E. Coffin regarding the Aircraft Industry, in which he said in part:

> I desire to state there is no intention upon the part of the Aircraft Production Board to attempt any concentration of the aircraft industry in Detroit. And I wish you would dispel at once, for all, any feeling that there is other than the fairest and most impartial of attitudes which actuates the Aircraft Production Board in its plans for providing aircraft for the military service.
>
> It is the desire of the Board that the closest possible relations be maintained between it and the Aircraft Manufacturers Association. We have a tremendous task on our hands, and it is going to require the most careful planning and co-operation to accomplish the proposed programme.

A canvass of the members indicated that they only awaited the word to proceed in a continued program that would enable it to expand to a degree sufficient to enable the industry to meet the immediate requirements for airplanes and at the same time further expand to meet the highest estimates that could be made based on the war-time experience of the Allies.

The committee has been in consultation with the authorities at Washington and made frank statements as to their ability to produce airplanes in quantity. The time has now arrived for prompt action and the association concurs in the plans as laid down to the individual manufacturers by the Aircraft Production Board.

Production of Training Machines

The afternoon session was devoted to a free discussion of the ability of the manufacturers to produce the training type of machines in quantity. The result of this was that it was found that while it was the sense of the meeting that the manufacturers preferred to make their own type of machine in the greatest possible quantities, and at the same time carry along the development of the Allies training type of airplane, it was also agreed that upon the completion of their work as of January 1, they would be well started on a fully developed program for this one type of aircraft. In view of the immediate needs of the Government for more of the training type of machine, the manufacturers say that they will sweep aside for the present their equipment suitable for regular production and concentrate on the Allies training type of machine, and follow later with their own types if desired.

Society of British Aircraft Constructors

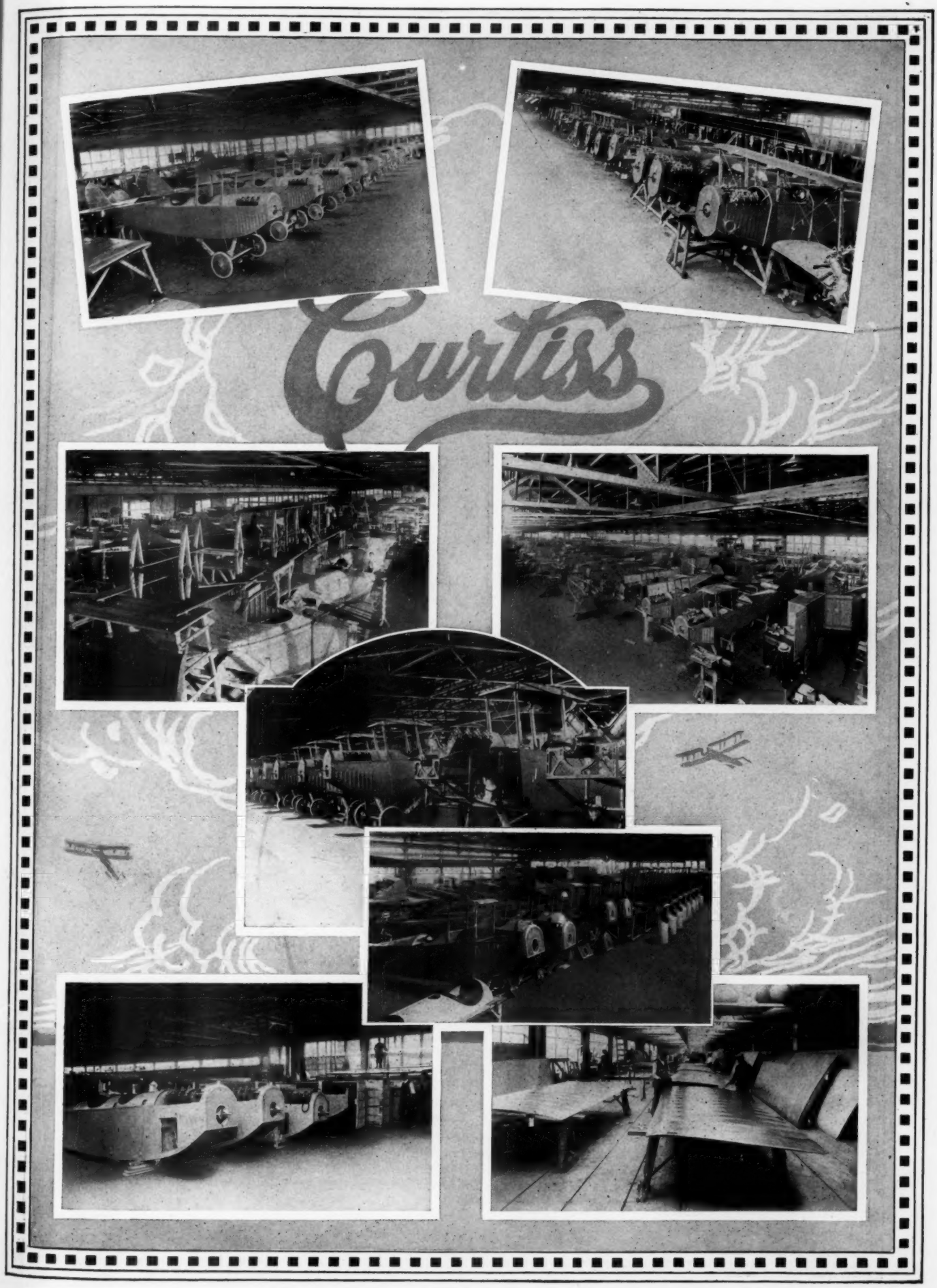
A communication was read from the Society of British Aircraft Constructors, in which they expressed a desire to have a close cooperation with the Aircraft Manufacturers' Association in America.

The British society is composed of the aircraft industry of England. They state that practically every British constructor of aircraft or aircraft engines is a member of this society. They expressed the belief that the future development of aviation would be greatly expedited by the close cooperation of the British and American industries, through their respective organizations.

This affiliation is perhaps one of the most important events that has occurred in the development of the aircraft industry. It brings to the industry through their respective associations, first hand information, free from personal bias, of aircraft and statements of facts, based on actual observation, developed from experience in the field and viewed from a manufacturer's standpoint.

It will be remembered at this point, that the aircraft industry in England at the beginning of the war, was vastly inferior to the aircraft industry in America at the present time; that with three years' experience, encouraged by vast appropriations from the Government, and hastened by actual warfare, the present output in finished planes is about eight hundred per week. The manufacturers engaged in this work have a capitalization of $375,000,000.

The industry in America has a capitalization of about $20,000,000 and based on a peace time equipment, we are able in a period of three months to turn out one-half as much as England.

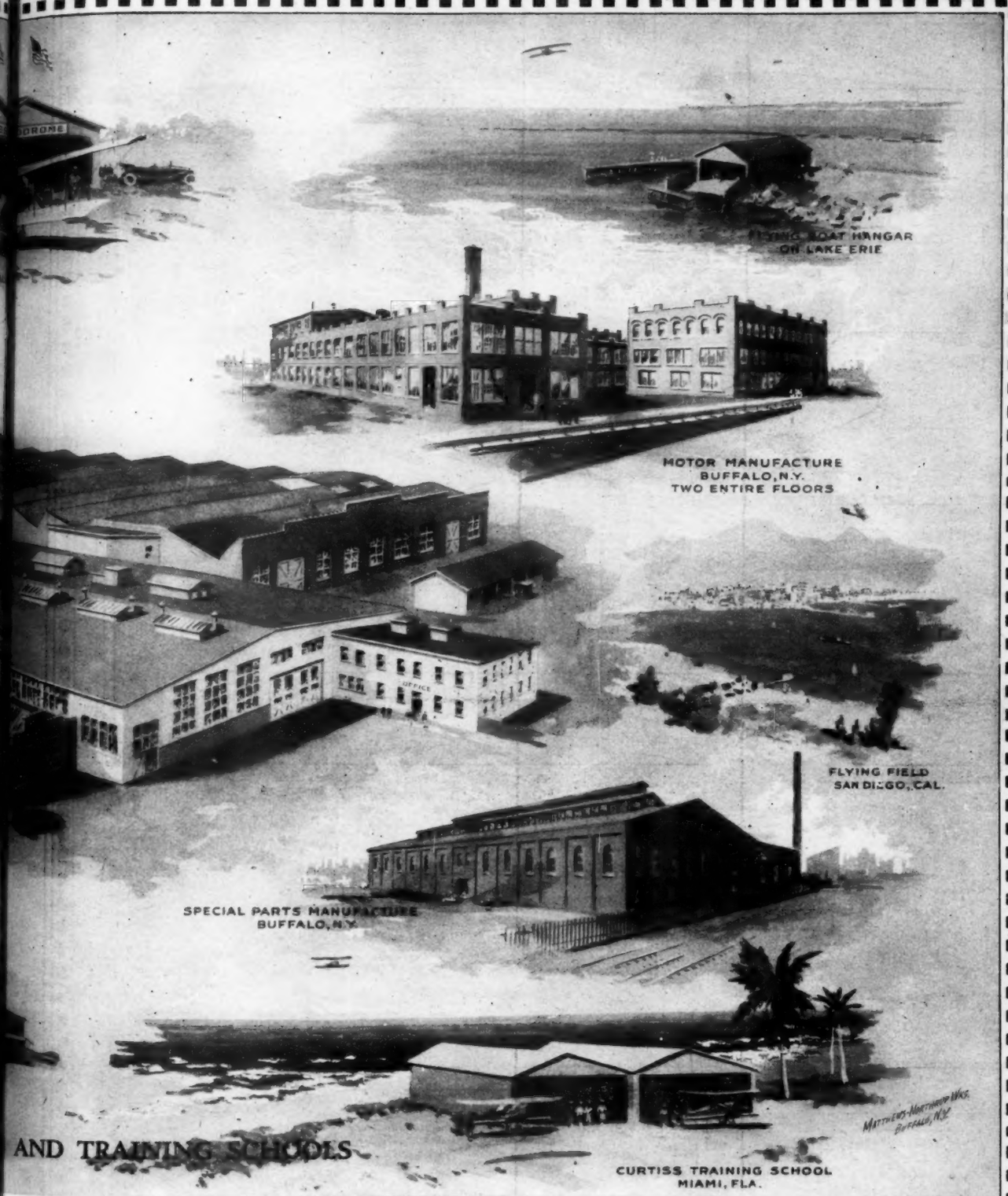


THE CURTISS AEROPLANE COMPANY, BUFFALO, N. Y.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents

THE Curtiss Aeroplane Co. has always been the dominating center of aviation in America. Its capacity has steadily grown until today it is the largest and best equipped aeroplane manufacturing corporation in the world, amply equipped with all facilities for building a large variety of types of aeroplanes, hydroaeroplanes, flying boats and aeronautical motors in *large quantities and for prompt delivery.*

THE CURTISS

CABLE ADDRESS



AND TRAINING SCHOOLS

OPLANE CO.

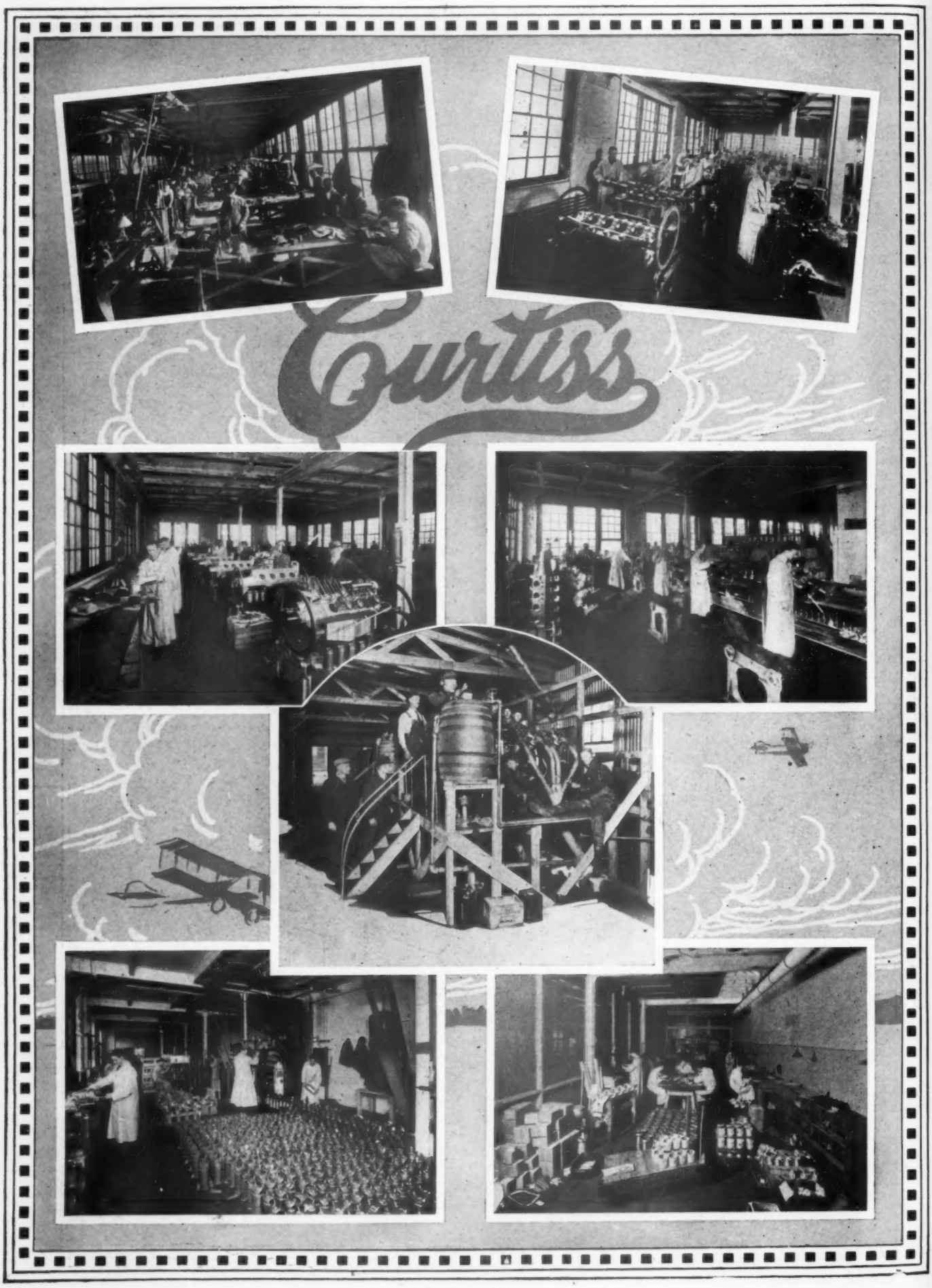
BUS. A.

ESS "WESTERN UNION CODE

IN addition to the main plant and executive offices in Buffalo, N. Y., there are four other branch factories—three in Buffalo, N. Y., and one in Hammondsport, N. Y., as well as Training Schools, Hangars and Flying Fields at Buffalo, Hammondsport, N. Y., Newport News, Va., Miami, Fla., and San Diego, Cal.

The America Trans Oceanic Co., 280 Madison Avenue, New York City, New York Agents.

Curtiss



THE CURTISS AEROPLANE AND MOTOR CORPORATION, BUFFALO, N. Y.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents.

Summer Meeting of the S. A. E.

On June 26, the semi-annual meeting of the Society of Automotive Engineers will be held at the Bureau of Standards, Washington. On account of the present national emergency, the meeting will be limited to one day. The usual business session will be held in the morning, when the Standards Committtee will report and routine business will be transacted.

At one of the meetings President George W. Dunham will deliver an address showing what the Society has been doing in national affairs in the past and also what it hopes to accomplish for the nation in the future.

The afternoon will be devoted to a professional session at which will be presented papers of far-reaching interest on airplane manufacture, motor truck operation under war conditions, the use of farm tractors in increasing the food supply of the nation, and the methods followed in the quantity production of submarine chasers.

In the evening an informal dinner will be held at the New Willard Hotel. The speakers who have already accepted invitations to address the members are: Secretary of War Newton D. Baker, General George O. Squier, Chief Signal Officer of the United States Army, and Colonel Chauncey B. Baker, chief of the Transportation Division of the Quartermaster Corps.

Meeting of Standards Committee

A meeting of the Standards Committee will be held at the Bureau of Standards on Monday morning, June 25. A number of the Divisions of the Committee, such as the Aeronautic, Marine, Tractor and Truck divisions, are spending all their time on work connected with government activities. This meeting is open to all the members of the Society and it is expected that a number of reports will be presented of universal interest.

In the afternoon, after the conclusion of the Standards Committee meeting, arrangements are being made to show the members through the buildings of the Bureau of Standards. The Bureau is housed in an imposing group of buildings, situated about four miles from the center of Washington City. The extensive laboratories devoted to research work along physical and chemical lines will be of interest to every member. Plans are being made for special exhibitions for the benefit of the members, showing the various activities of the Bureau.

Papers at Professional Session

While only a comparatively small number of papers will be presented at the professional session, which will be held on the afternoon of Tuesday, June 26, every one of them will be of the most vital importance. The paper on aeronautics is to be given by Wing Commander I. W. Seddon, R. N. A. S., who is a member of the British Commission in this country. It is expected that his paper will deal with the practical effects of airplane manufacture, and will include a great amount of information needed by manufacturers and engineers in this country. Commander Seddon has had much practical experience in operating airplanes on the Somme front.

Frank H. Russell on Automotive Committee of National Defense Council

Frank H. Russell, President of the Aircraft Manufacturers Association, has been appointed a member of the Automotive Committee of the Council of National Defense.

COL. WILLIAM MITCHELL, U. S. A.

Col. Mitchell Honored

According to a dispatch from Paris, for efficiency and bravery, in the face of the enemy, Col. Mitchell, aviation attaché of the American military mission to France, has been cited in general orders. This is the first instance of its kind that has fallen to the lot of an American regular army officer since the outbreak of the war.

Col. Mitchell was sent to the front several weeks ago to study flying problems at first hand. It was during an infantry attack that he performed deeds of great valor, flying close to the ground in order to guide the movements of the attacking troops.

Col. Mitchell, who this month was made a Lieut.-Colonel, for several years was on the General Staff of the United States Army and before being ordered to France on aviation duty by the Secretary of War was assisting General Squier to organize the Aviation Section of the Signal Corps.

G. C. Loening Returns

Grover C. Loening is back in this country from a trip to England, where he had an opportunity of inspecting many of the English flying fields, factories and naval stations.

The Army Schools

The nine Army schools estimated in the Army appropriation bill are as follows:

Mineola, L. I.	(Operating.)
Ashburn, Ills.	(Operating.)
San Diego, Calif.	(Operating.)
Mt. Clemens, Mich.	(Ordered and under construction.)
Fairfield, Ohio.	(Ordered and under construction.)
Rantoul, Ills.	(Ordered, construction to begin at once.)
San Antonio, Texas.	(Under construction.)
So. Miss. Valley.	(Under investigation.)

The ninth school has not yet been located, but the War Department contemplates its location to be in the Rocky Mountain region. Other schools will doubtless be established as exigencies require, and in addition to the training schools established on United States soil, the Department has let contracts for the immediate establishment of a two squadron school in France, which will be built and equipped by American contractors. The site has been selected, and all construction material will be shipped from this country. Training at this school will be on French machines and under French Army instructors.

The 1st Aviation School Squadron is located at San Diego, the 2nd at Mineola, the 3rd and 4th at Ashburn; the 1st and 2nd Reserve Aviation Squadrons are at Mineola and Essington, Pa. respectively, while seven aero squadrons have been organized and are on duty as follows: 1st, at Columbus, N. M.; 2nd in the Philipines; 3rd, 4th and 5th at San Antonio, Texas; 6th at Honolulu, and 7th on the Canal Zone.

Squadron Notes

Six machines have been received by the 4th Aero Squadron at San Antonio. Infantry drill with and without arms is held five days a week, from 7-11 a. m. and 1-3 p. m.

A total of 434 flights of 239 hours and fifty minutes in the air were made during the week by the 1st Aviation School Squadron at San Diego. The officers received instruction in aero engines, motor cycles, construction and repair of airplanes and radio telegraphy. The enlisted men received practical work on engines, together with military instruction.

Some forty flights were made during the week by the 1st Aero Squadron at Columbus, N. M., with a total of nine hours and nineteen minutes in the air. Six machines have been received. Captain Mills left for duty at the Massachusetts Institute of Technology, one of the ground schools for pilots.

Marine Corps Aviation Station

The Marine Corps is establishing an advance base flying school on League Island near Philadelphia. The field, hangar and equipment formerly used by the Aero School of Pennsylvania, have been turned over to the Corps, and Capt. A. A. Cunningham is in charge.

Winston Churchill Heads British Air Board

It is announced from London that Col. Winston Spencer Churchill has accepted the Chairmanship of the British Air Board, in succession to Viscount Cowdray.

Winston Churchill was First Lord of the Admiralty when the war began. He was severely criticized for certain naval measures he was said to have fathered, and for losses that had attended the British fleet—the sinking of the Aboukir, Cressy, and Hogue by a German submarine in the North Sea, the loss of Sir Christopher Cradock's squadron off Chile, and the Gallipoli fiasco—and when the Asquith Ministry was reconstructed in May, 1915, and made a coalition Cabinet, he was relegated to the post of Chancellor of Lancaster, which he filled without salary until the following November, when he resigned and went to the front with the rank of Colonel. Since then he has written much on the war and, as a member of Parliament from Dundee, has made several notable speeches in the House of Commons, principally in defense of his policy while First Lord.

He is the son of the late Right Hon. Lord Randolph Churchill and Lady Randolph Churchill (née Jerome of New York). Before the war he was looked upon as England's rising man.

Death of Capt. Ball

The British War Office has received confirmation that Captain Albert Ball, one of Great Britain's most noted aviators, was killed in action some time ago. Captain Ball had been missing since May 7.

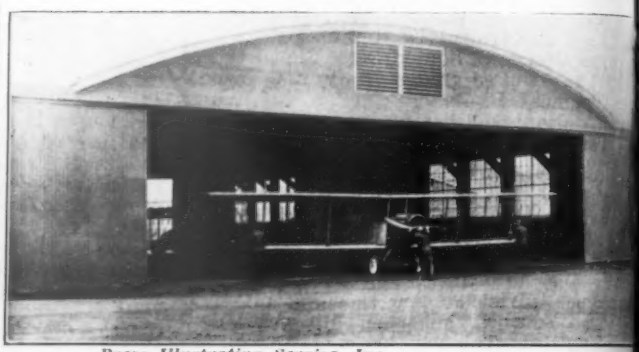
The aviator had made a brilliant record, his score of enemy airplanes shot down up to the early part of the year having been twenty-nine. He was only twenty-one years old.

Copyright Royal Flying Corps

ROYAL FLYING CORPS FIE

Copyright Royal Flying Corps

CADET MILITARY AVIATORS



Press Illustrating Service, Inc.

The pictures of Camp Borden and its p
Corps, indicate the magnitude of the schem
Canada.

The lower picture shows the fifteen hang
shows the officers' and cadets' quarters. The
officers and enlisted men are shown in the
chines is also shown.

These pictures bring out clearly the lar
sary to train even a few military aviators.

Recruiting for the Royal Flying Corps
who might be eligible can secure there all
are being recruited, it is interesting to

Copyright Royal Flying Corps

MP BORDEN, CANADA

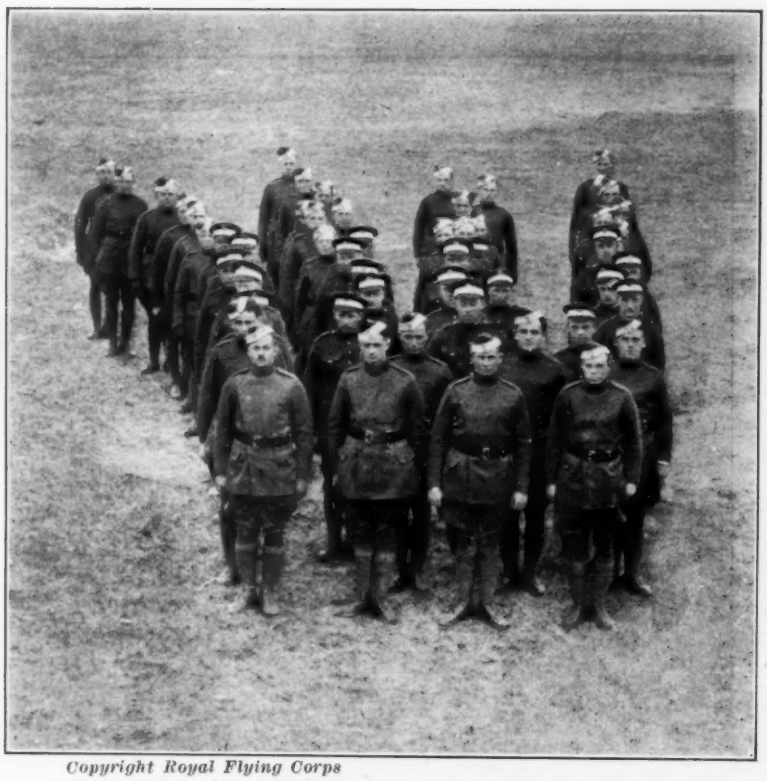
Press Illustrating Service, Inc.

duced through the courtesy of the Royal Flying one of several that have been established in

modating six airplanes. The upper picture n the side show the cadet aviators, while only A close view of one of the hangars and ma-

mechanics and other camp personnel neces-

on at 280 Broadway, New York, and those sired. While Canadians and English subjects of the officers and men are Americans.



Copyright Royal Flying Corps

CADET MILITARY AVIATORS

Army and Navy Orders

Capt. Frank Page, S.O.R.C., son of Walter Hines Page, the American Ambassador to London, has been ordered to active duty and assigned to the office of the Chief Signal Officer as manager of cadet training. He will visit the Canadian aviation school at Camp Borden to investigate the system in vogue there. Other recent details to General Squier's office include Capt. William Larned, S. O. R. C., who for several years was the national tennis champion; and Capt. R. B. Owens, S. O. R. C., until recently secretary of the Franklin Institute. Captain Larned has been assigned to the examining board which passes upon candidates for commission in the aviation section.

Capt. Ralph L. Taylor, S. O. R. C., to active duty at Mineola, Long Island, N. Y.

First Lieut. Warren C. Woodward, S. O. R. C., from Memphis to Fort Sam Houston, Texas, to duty with the 3d Aero Squadron.

Capt. Walter R. Taylor, S. O. R. C., to active duty at headquarters, Southern Department.

THREE MEMBERS OF THE BRITISH AND FRENCH FLYING CORPS NOW IN THIS COUNTRY. (LEFT TO RIGHT), LIEUT. DE LA GRANGE, OF THE FRENCH COMMISSION, MAJOR L. W. B. REES, OF THE BRITISH FLYING CORPS, AND MAJOR TULASNE, OF THE FRENCH FLYING CORPS.

First Lieut. Roderick H. Jones, S. O. R. C., to active duty at Aviation School, Mineola, Long Island, N. Y.

First Lieut. Clarke Thomson, S. O. R. C., to active duty at Fort Sam Houston, Texas, with 3d Aero Squadron.

First Lieut. Victor W. Page, S. O. R. C., to active duty at Mineola, Long Island, N. Y.

Each of the following officers will report to board at Aviation School, San Diego, Cal., for examination for rating as junior military aviators: Capt. Guy L. Gearhart, C. A. C.; 1st Lieuts. Thurman H. Bane, 8th Field Art.; Claude K. Rhinehardt, 17th Cav.; Norman W. Peek, Inf., D. O. L.; Thorne Duel, Jr., Cav., D. O. L.; John C. Prince, Cav., D. O. L.; Harvery B. S. Burwell, 13th Cav.; Warren P. Jernigan, Cav.; John E. Rossell, Inf.; Norman J. Boots, 10th Cav., and William B. Peebles, Cav.

Capt. George E. Stratemeyer, S. C., to Columbus, Ohio, for duty at Ohio State University.

Major Alfred T. Clifton, S. C., to Fort Sam Houston, Texas, for duty as signal officer of Southern Department.

Capt. Leo G. Heffernan, 3d Aero Squadron, S. C., to Aviation School, San Antonio, for duty.

Capt. John N. Reynolds, Av. Sec., S. C., to Fort Sam Houston, Texas, for duty.

Capt. Paul L. Ferron, junior military aviator, S. C., detailed as aeronautical officer of the Southern Department, vice Major Townsend F. Dodd, S. C., relieved.

First Lieut. Howard P. Culver, Av. Sec., S. O. R. C., to active duty at Fort Sam Houston, Texas.

Capt. J. L. Dunsworth and 1st Lieut. Patrick Frissell, Av. Sec., S. C., to Fort Sam Houston for duty.

First Lieut. W. N. East, Av. Sec., S. C., to Columbus, N. M., duty 1st Aero Squadron.

Major Henry B. Hersey, Av. Sec., S. O. R. C., to active duty at Balloon School, Fort Omaha.

Officers of Aviation Section, S. O. R. C., to active duty; report in person to commanding general, Southern Department, for assignment: Capt. Max C. Fleischmann, Capt. Pierre DeL. Boal; 1st Lieuts. Daniel P. Morse, Stephen H. Noyes and Daniel Buckley.

First Lieuts. Seth Low and Cord Mayer, S. O. R. C., to Governors Island, N. Y., for duty.

First Lieuts. H. M. Gallop, W. G. Shauffler, W. V. Barnaby and W. C. Rolph, S. O. R. C., to Columbus, N. M., for duty with 1st Aero Squadron.

First Lieut. Daniel Buckley, Av. Sec., S. O. R. C., to active duty, Fort Sam Houston with an aero squadron.

North Island Site.

A bill authorizing the President to take possession of, on behalf of the United States, and to use as sites for permanent aviation station for the Army and Navy, the whole of North Island, in the harbor of San Diego, Cal., was introduced in the House on June 6 by Chairman Dent, of the Committee of Military Affairs. The property will be appraised and the value adjudged by a board of real estate experts.

Navy Aviation Stations

Civil Engr. F. H. Cooke, U. S. N., has been detailed to take charge of the construction of buildings at seven aviation stations along the coast. It is estimated that $100,000 will be expended at each of the sites, which are as follows: Montauk Point, L. I.; Rockaway Beach, L. I.; Cape May, N. J.; Philadelphia, Pa. (Navy Yard); Old Point Comfort, Va.; Key West, Fla., and near Colon, C. Z.

Fort Sam Houston.

Instructions have been received at the headquarters of the Southern Department at Fort Sam Houston, Texas, to establish at the aviation camp there twenty-seven aero squadrons. These are to be of a strength of 150 men each, giving a strength to the camp of 4,050 men. There are to be twenty-four airplanes to each squadron, making a total of 648 machines for the San Antonio Aviation Camp. There are twelve machines in use in each squadron and twelve held in reserve. 4,500 recruits have already been enlisted for the camp and these are being sent from all parts of the country. Capt. S. W. Cook, Cav., U. S. A., is the commanding officer of the aviation camp.

New Dirigible Built for Navy Flies More Than 400 Miles

The Navy Department authorizes the following:

Reports have reached the Navy Department that the first of the sixteen non-rigid dirigibles being built for the Navy has made a successful flight of more than 400 miles. This dirigible left Chicago at midnight and arrived at Akron, Ohio, between four and five o'clock the next afternoon. As this was merely an experimental flight and not an official test, no attempt was made to attain high speed. The contract requires that these balloons make 40 miles an hour.

This is a new type of airship designed by the Navy Department, and is on the order of the "blimps," the non-rigid dirigibles which England has been using with such success. The design was prepared by Naval Constructor J. C. Hunsaker, of the Bureau of Construction and Repair, under the direction of Admiral Taylor, chief of the bureau.

Sixteen Contracted For

Sixteen were contracted for some two months ago. The Goodyear Tire & Rubber Co. is building nine and the others are being built by The B. F. Goodrich Co., the Curtiss Aeroplane Co., and one by the Connecticut Aircraft Co. It is expected that they will hereafter be completed at the rate of one a week and that will be delivered by August.

The American "blimps" will form a part of the coast patrol and will be distributed along the coast as lookout to watch for the approach of enemy vessels. The English have found this type very effective in detecting submarines.

War of 1917 Pension Claim

Among the claims filed in the Bureau of Pensions on account of our present war is one by Susie A. Van Kirk, of Washington, D. C. She was the mother of Dean R. Van Kirk, who was an ensign and attached to the Naval Battalion, National Guard of the District of Columbia. He died on May 1, 1917, at Pensacola, Fla.

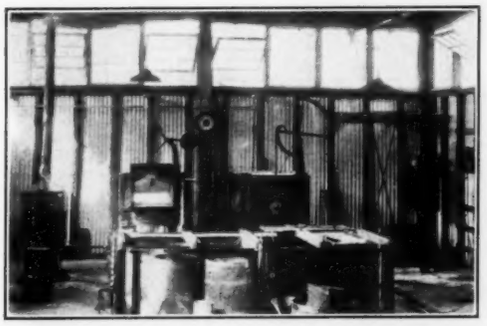
On account of the death of a person in the aviation service the pension is double the amount of the ordinary pension under like circumstances.

A THOROUGHLY EQUIPPED PLANT

PREPARED TO PRODUCE COMPLETE

AIRPLANES OR PARTS

IN QUANTITY



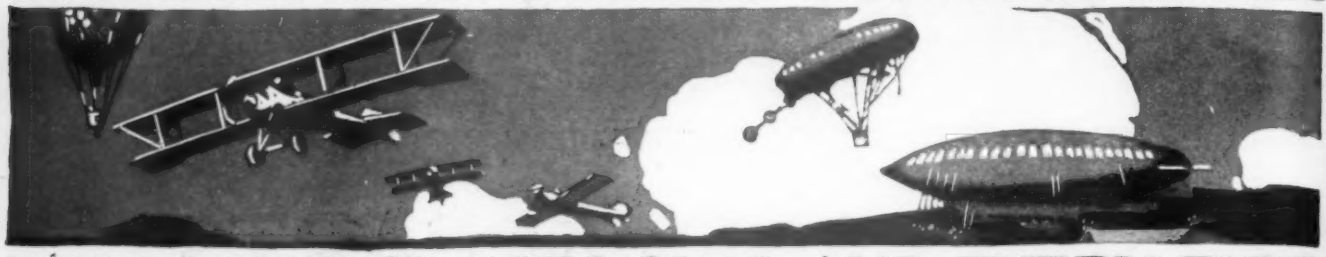
BACKED BY 52 YEARS MANUFACTURING EXPERIENCE

1865 1917

ROGERS CONSTRUCTION CO.

GLOUCESTER CITY NEW JERSEY

EVERYTHING IN RUBBER FOR AIRPLANES



BALLOONS OF ANY SIZE AND EVERY TYPE

Each Dirigible Commands the Experience of Many Goodyear Departments

The busy activity on the spacious Goodyear floors devoted to dirigible construction represents merely the visible focus of effort closely co-ordinated but widely separated.

These floors are only the assembling rooms of the past experience and present production of many departments.

As such they are impressive, but they are not vital.

Were they to disappear today, Goodyear construction would still go on tomorrow.

For the manifold production, the technical ability, the hard-won experience essential to successful dirigible construction would remain.

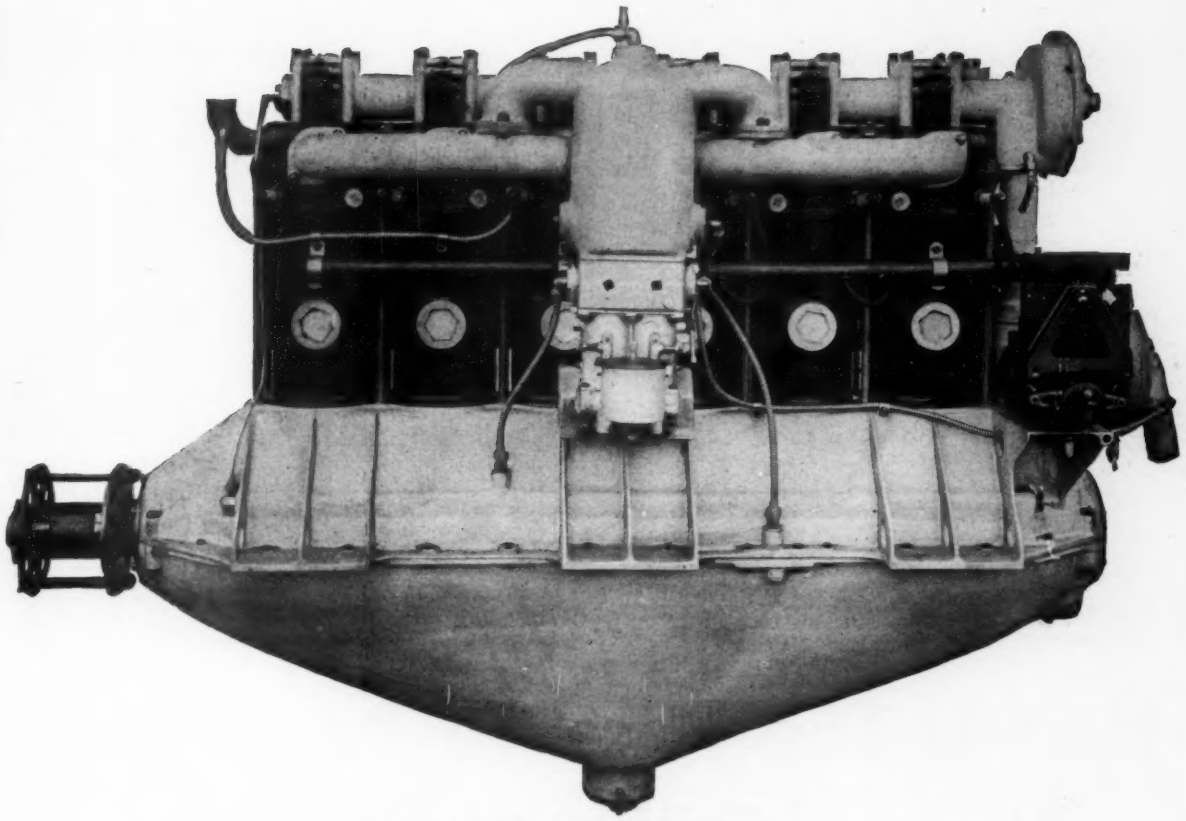
And by the day long since specified the Goodyear dirigibles now being built would take their clattering flight over the Goodyear testing ground.

They are not, and could not be the product of a few great rooms and some frantic months of labor, but are the creation of many factories and groups whose experience and skill the Goodyear department of aeronautics has commanded to its service through six pioneering years.

The Goodyear Tire & Rubber Co.
Akron, Ohio

GOODYEAR
AKRON

HALL-SCOTT



Intake Side Hall-Scott, "BIG SIX" Airplane Engine

This Hall-Scott, Type A-5a, rated at 150 H.P., is offered after having most successfully passed severe running tests as required by Hall-Scott engineers, and final 48 hour endurance, running test, on cradle type torque stand, with propeller directly connected, in accordance with U. S. Government requirements. (Spec. 1002.)

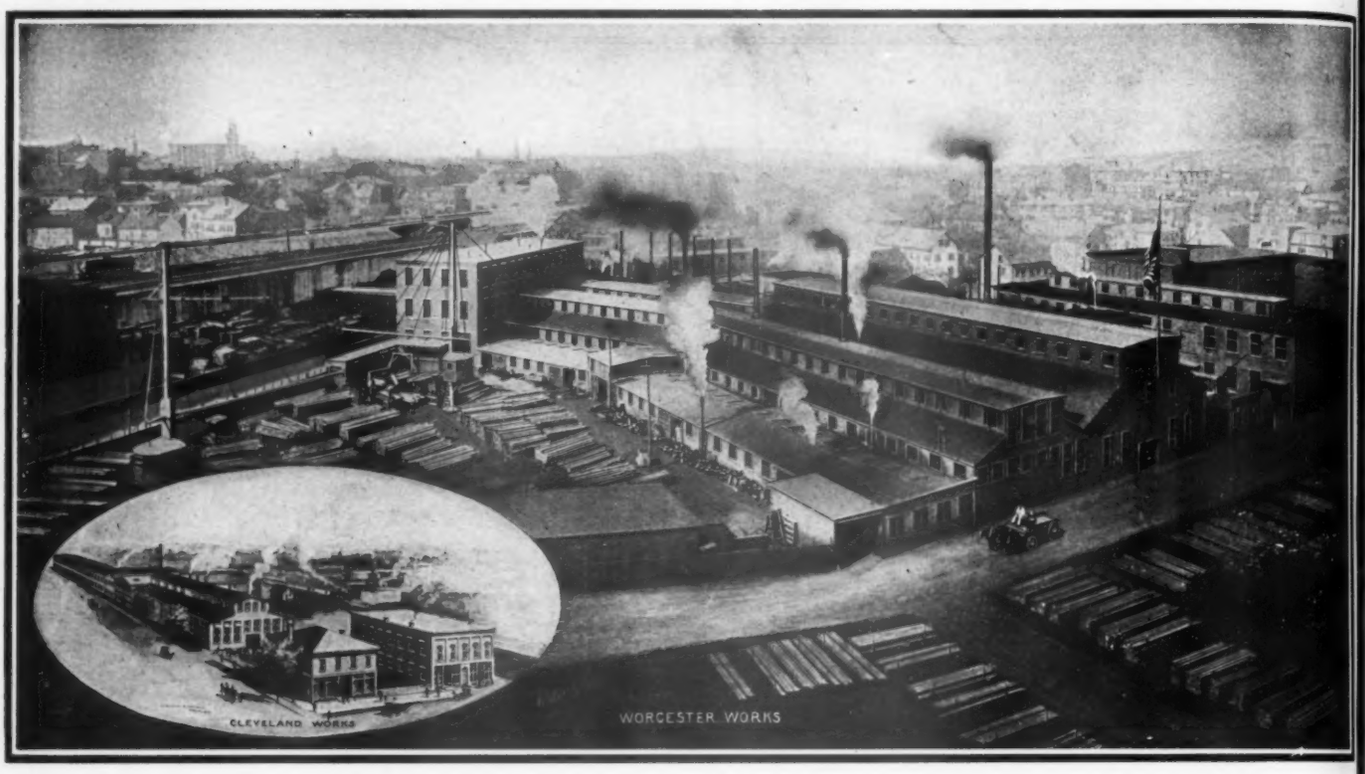
Total weight, complete and ready for service,	*578 lbs.*
Weight per H.P. (Based on actual H.P. development, at 1,300 R.P.M.)	*3.61 "*
Consumption gasoline in lbs. per H.P. hour,	*.565*
" lubricating oil " " "	*.025*

HALL-SCOTT AIRPLANE ENGINES, both four and six cylinder types, are used by U. S. Army and Navy Departments, and are generally used by all leading American airplane manufacturers.

Hall-Scott Motor Car Co., Inc.
General Offices
Crocker Bldg., San Francisco, Calif.

F. P. Whitaker
EASTERN REPRESENTATIVE
165 Broadway, New York City

WYMAN—GORDON



Here Is The Place To Bring Your Aircraft Crankshaft Problems!

Specialists in the working and treatment of steel for thirty years, we are fully equipped to meet the special problems presented in the Aircraft Engine.

Not only do we guarantee you design, workmanship, material and delivery, but we promise you a lively interest and complete co-operation in arriving at the most satisfactory fulfillment of your own particular requirements.

This means satisfaction, it means the comfort that comes of certainty, of the knowledge that your engine parts are all that they should be, all that they possibly could be within the bounds of human effort.

And it means true economy of production, for our aim is to produce forgings fully competent to bear the burden thrown upon them, at the least possible cost of production.

WYMAN-GORDON COMPANY, WORCESTER, MASS.

CLEVELAND DETROIT

GUARANTEED FORGINGS

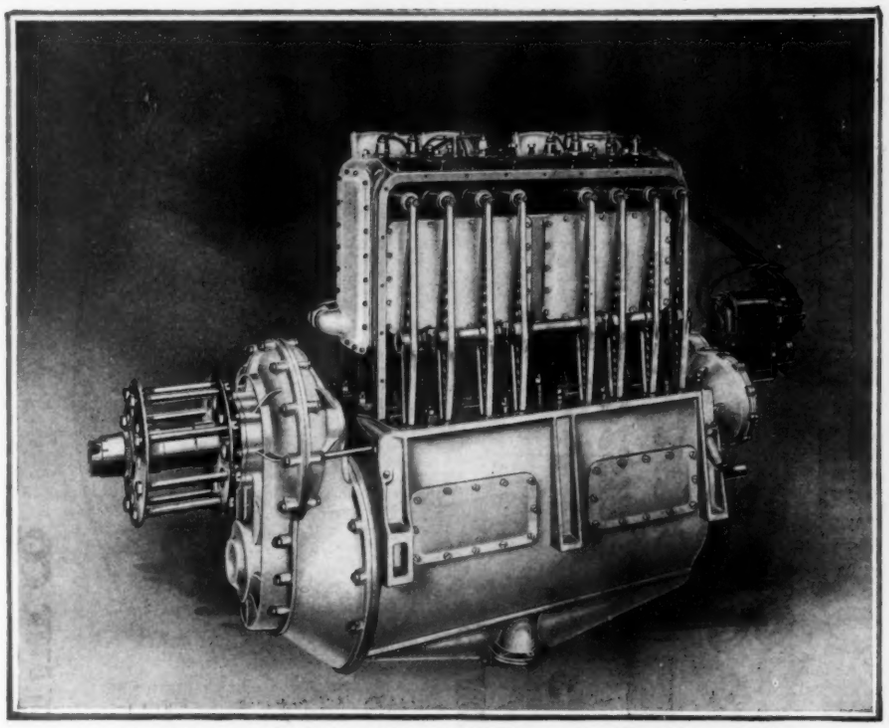


ILLUSTRATION WITH VALVE COVER REMOVED TO SHOW VALVE ACTION

Brief Specifications

Sixteen Valve Duesenberg Aeroplane Motor

FOUR cylinder 4¾" x 7", 125 H.P. at 2100 R.P.M. of the crankshaft and 1210 R.P.M. of the propeller. Motors are sold on above rating; actual power tests prove this motor capable of developing 140 H. P. at 2100 R. P. M. of the motor. The exact weight with magneto, carburetor, gear reduction and propeller hub, as illustrated, 509 lbs. Without gear reduction, 436 lbs. Net price of this four cylinder motor with regular engine equipment but not with reduction gear, $3050.00; net price with reduction gear, $3500.00.

Cylinders are semi-steel with aluminum plates enclosing water jackets. Pistons specially ribbed and made of Magnalite aluminum compound. Piston rings of special Duesenberg design, being three piece rings. Valves are Tungsten Steel, $1\frac{15}{16}$" inlets and 2" exhausts, two of each to each cylinder. Arranged horizontally in the head, allowing very thorough water-jacketing. Inlet valves in cages. Exhaust valves, seating directly in the cylinder head, are removable through the inlet valve holes. Valve stems lubricated by splash in the valve action covers. Valve rocker arms forged with cap screw and nut at upper end to adjust clearance. Entirely enclosed by aluminum housing as is entire valve mechanism. Connecting rods are tubular, chrome nickel steel, light and strong. Crankshaft is one piece forging, hollow bored, 2½" diameter at main bearings. Connecting rod bearings 2¼" diameter, 3" long. Front main bearing 3½" long; intermediate main bearing 3½" long, rear main bearing 4" long. Crankcase of aluminum, barrel type, oil pan on bottom removable. Hand hole plates on both sides. Strongly webbed.

Full and complete information will be cheerfully supplied and every courtesy extended to you in carrying out your investigations. Our factory facilities are such that satisfactory deliveries can be made.

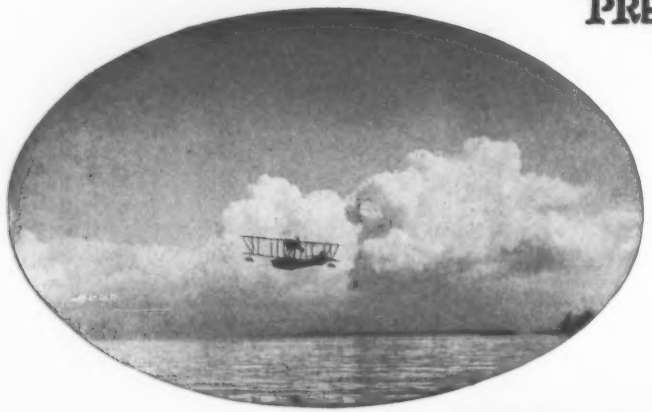
Duesenberg Motors Corporation

120 Broadway, New York City

THE NEW WATER SPORT OF THE SUPERMAN

Instruction in a General Aeroplane Co's Verville Type Flying Boat will convert the ardent speed motor boat enthusiast to the virile man making sport of flying

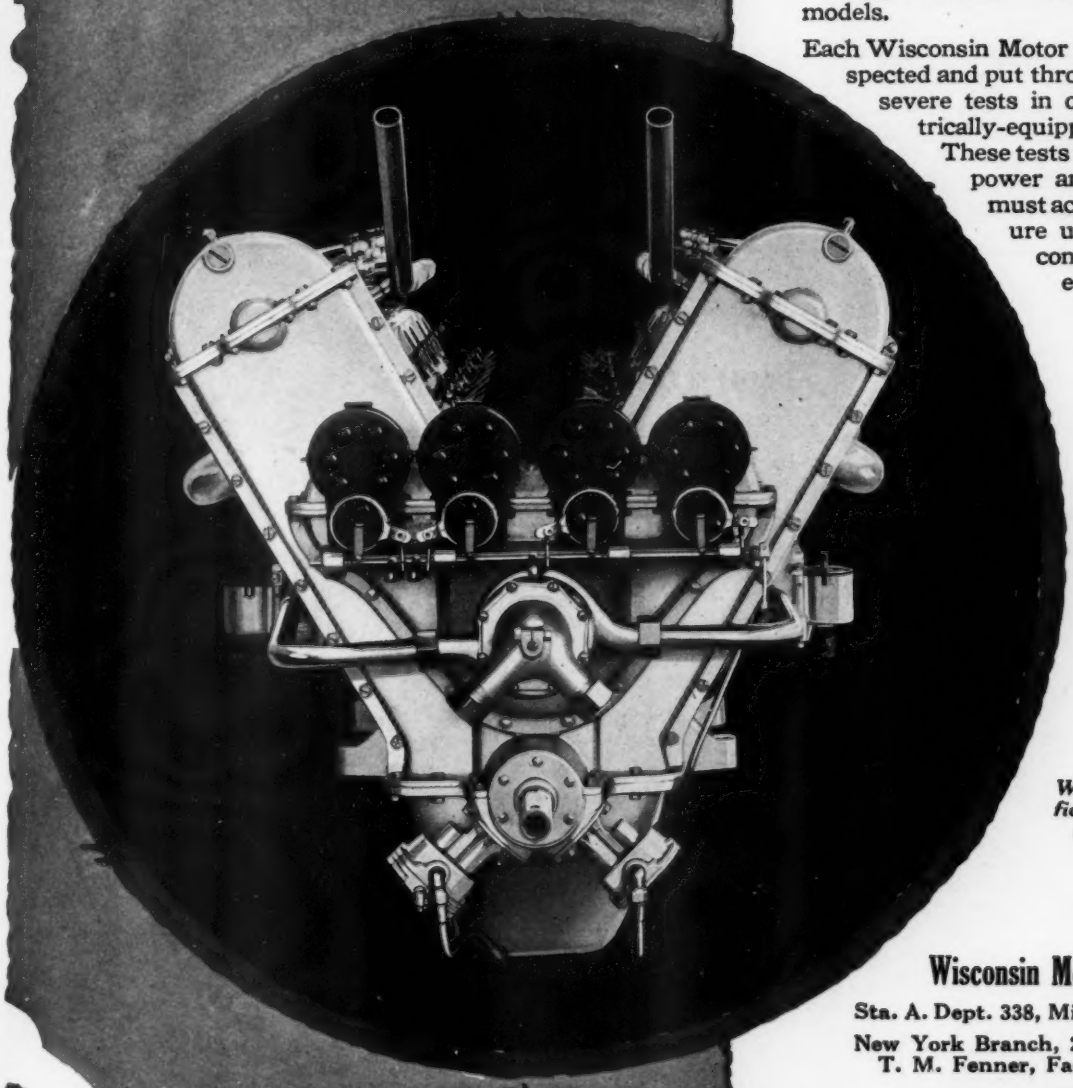
"PREPAREDNESS"



Office — 1507 East Jefferson Ave

GENERAL AEROPLANE CO.
Detroit U.S.A

Hangars Old Detroit Motor Boat Site



Wisconsin
CONSISTENT
AEROPLANE MOTORS

ON land—in Speedway and Long Distance Racing, Wisconsin Motors have been proclaimed champions of the world.

On water they have also distinguished themselves and earned recognition for splendid performance.

In the air, Wisconsin Aeroplane Motors can be depended upon for the same efficient service that has characterized the other types of this motor on land and sea.

Consistent—that's the word that has ever been linked with Wisconsin Motors—and it is truly descriptive in its application to our Aeroplane models.

Each Wisconsin Motor is critically inspected and put through a series of severe tests in our large, electrically-equipped test room. These tests insure uniform power and each motor must accurately measure up to the Wisconsin standard in every detail.

Two Sizes

6 cylinder, 5-inch bore, 6½-inch stroke.

12 cylinder, 5-inch bore, 6½-inch stroke.

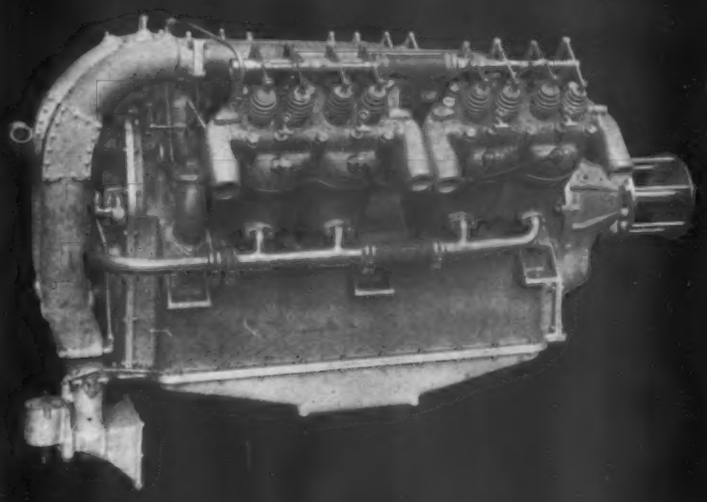
Write for full specifications of six and twelve-cylinder models.

Wisconsin Motor Mfg. Co.

Sta. A. Dept. 338, Milwaukee, Wis.

New York Branch, 21 Park Row
T. M. Fenner, Factory Rep.

Sturtevant
(REG. U.S. PAT. OFF.)



SEND FOR CATALOG

B. F. STURTEVANT COMPANY
HYDE PARK, BOSTON, MASS.

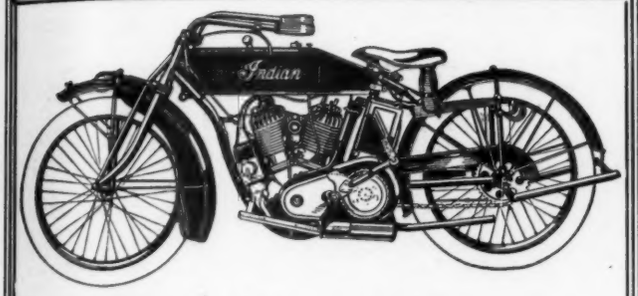
Announcement

Knabenshue Aircraft Corporation

DIRIGIBLE CONSTRUCTORS

140 WEST FORTY-SECOND STREET
NEW YORK CITY

A. ROY KNABENSHUE
GENERAL MANAGER



In Every Branch of Military Service

where motor-propelled vehicles are chosen for their known dependability in every emergency, can be found the 1917

Indian Motocycle
With Powerplus Motor

A machine that has proved itself time and time again the master motorcycle.

We will gladly arrange demonstrations of the 1917 Indian models for interested military officials.

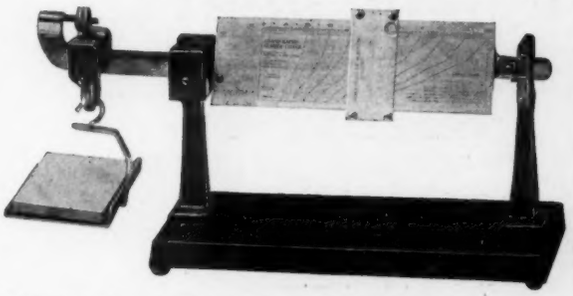
Illustrated 1917 Indian Catalog and other descriptive literature sent anywhere on request

HENDEE MANUFACTURING COMPANY

(Largest Motorcycle Manufacturers in the World)

859 STATE ST. SPRINGFIELD, MASSACHUSETTS

GRAND RAPIDS LUMBER TESTER



KNOW the MOISTURE CONTENT of your LUMBER

DIRECT READING—NO COMPUTATION—NO GUESSWORK

All air-dried lumber for AIRPLANES should be tested to insure uniformity.

Lumber should contain from 5 to 10 per cent. moisture for manufacturing purposes, according to kind of work.

Lumber containing less will absorb moisture from the air and expand.

Lumber containing more will expel the surplus and shrink.

Determine time required for drying by testing before loading kiln.

Determine if lumber is dry by testing before "pulling" kiln.

The Grand Rapids Lumber Tester is based on "bone dry" or constant weight and is scientifically correct, according to the standards of the U. S. Forest Laboratory at Madison, Wisconsin.

GRAND RAPIDS VAPOR KILN

Manufactured by GRAND RAPIDS VENEER WORKS

Grand Rapids, Mich. Seattle, Wash.

METAL AIRPLANE FUSELAGES

AEROPLANE TUBING

Especially made to your own requirements.

We are at present manufacturing for the largest aeroplane manufacturers both here and abroad our high grade tubing and metal fuselage, made to special requirements.

We have exceptional facilities for almost overnight deliveries.

The Empire Art Metal Co., Inc.

COLLEGE POINT, N. Y.

Heavy Elastic Aviation Cord

We manufacture a full and complete line of heavy elastic aviation cord.

We are the originators and the largest manufacturers in the world of heavy elastic cord.

Standard H-3 equipped with our cord

J. W. WOOD ELASTIC WEB CO.

STOUGHTON, MASS.

CAPACITY QUALITY

DU PONT

WHERE LARGE PRODUCTION CONVERGES WITH THE MOST RIGID STANDARDS OF QUALITY AND EFFICIENCY

¶ Du Pont facilities and capacity can be depended upon to keep pace with the increased demands of the airplane industry.

¶ Du Pont technical skill and experience will insure strict maintenance of the quality that has made **DU PONT DOPE** the standard for airplane surfaces.

Du Pont Chemical Works

E. I. du Pont de Nemours & Co., Owner

120 Broadway New York

Radium Luminous Material

SHINES IN THE DARK

SELF-LUMINOUS REQUIRES NO MAINTENANCE OVER A PERIOD OF YEARS

INNUMERABLE USES IN ITS ORIGINAL POWDERED FORM OR APPLIED WITH ADHESIVE

A SAFETY DEVICE FOR WAR

ON

MACHINE GUN, PISTOL AND RIFLE SIGHTS; RANGE SCALES; AUTOMATIC TELEPHONES; WIRELESS APPARATUS; NAVIGATING INSTRUMENTS OF ALL FLYING AND SAILING CRAFT; DECK CLOCKS; WRIST, STOP AND POCKET WATCHES; SIGNALS; PLOTTING BOARDS; ETC.

Radium Luminous Material Corporation

FIFTY FIVE LIBERTY STREET

SEES AT NIGHT

NEW YORK CITY

Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

THE STANDARD

CLOCKS

FOR USE ON

AEROPLANES *and* SEAPLANES *&c.*

The Justly Celebrated

8 DAY—HIGH GRADE

"CHELSEA"

CORRESPONDENCE SOLICITED

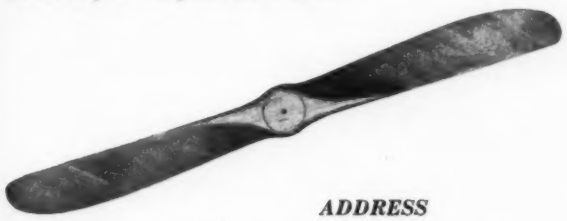
CHELSEA CLOCK CO.

10 State Street, Boston, Mass., U.S.A.

"WESTMOORE PROPELLER"

Built for high power motors
Water proof and heat proof

Write for information



ADDRESS

Aircraft Department
Schweizer & West Mfg. Co.
308-324 N. Ada St., Chicago

Cable address "SWESCO"

Cabinet makers with over thirty years' successful business behind them

Sturtevant

(REG. U. S. PAT. OFF.)

Aeroplane Company

Jamaica Plain Boston

Member Aircraft Manufacturer's Association

Factors of Safety

These Count in Aeroplane Construction

NON-INFLAMMABLE

Cellulose Acetate Base

Celestron Cloth Varnishes

provide another SAFETY FACTOR

NON-INFLAMMABLE

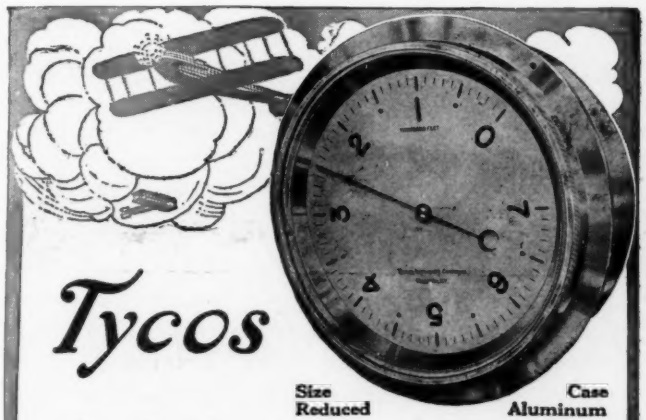
Celestron Sheets AND Films

Transparent — Waterproof

MANUFACTURED BY

Chemical Products Company
93 Broad Street Boston, U. S. A.

Manufacturers of Cellulose Acetate for nearly 15 years



Tycos

Size Reduced — Case Aluminum

Aviation Barometer

Made in United States.

Movement compensated to overcome changes in temperature. Dial revolves so zero of altitude can be set at the hand at start of flight without showing error, as scale is equally divided.

Supplied to U. S. Navy, U. S. Signal Corps, leading manufacturers and to different Foreign Governments.

In material, workmanship, pride of manufacture, no effort is lost, no expense spared to make this Barometer worthy of the Tycos Reputation.

Let us submit information on this Barometer as well as on Inclinometers and Pocket Altitude Barometer—the purchasing we leave to your discerning judgment.

Taylor Instrument Companies

Rochester, N. Y. U. S. A.

For sixty years makers of scientific instruments of superiority

ELJ-5

Officers of the Heavier-than-air Services of the United States and their Allies are invited to inspect the

Janney Aircraft Company's

New Model Training Tractor Biplane ELJ-5

With Hall-Scott A-5 Six Cylinder Engine

Detailed Description upon request

JANNEY AIRCRAFT CO.
MONROE, MICH.

Wittemann-Lewis Model T-T, 90 h. p.

WITTEMANN - LEWIS AIRCRAFT COMPANY
NEWARK, N. J.

Main Office and Factory:

Lincoln Highway, near Passaic River
Telephone, Market 9096

New York Office: 17 Battery Place
Telephone Rector 2461

With the manufacturing facilities of three large factories in New York, Tennessee and New Jersey we are in a position to execute with despatch orders for the LANZIUS CHANGEABLE ANGLE OF INCIDENCE AIRPLANE in any type for land or water, or for Standard and Special Design Aircraft, either wood or steel construction. We furnish with our standard equipment Duesenberg Motors, recognized as one of the most powerful and efficient Aeronautical Motors on the market.

LANZIUS AIRCRAFT COMPANY
Executive Offices
608-609-610 Singer Building, 149 Broadway, New York
Telephones 6710-6711 Cortlandt

BENOIST

Four Standard Models

Single and Twin Motored

Three to Seven Passengers

Holder of many World and American Records

Six Years Practical Experience

Land and Water Airplanes

On application by interested parties, we will submit specifications on triple and four motored machines carrying as many as twenty passengers, and guarantee performance.

Benoist Aeroplane Company
SANDUSKY, OHIO

McADAMITE-ALUMINUM COMPANY

57-83 Isabella Ave. DETROIT, MICH.

Highest-Grade—Strongest

ALUMINUM CASTINGS

Tensile strength.....	44,250	lbs. Sq. In.
Compression	126,000	" " "
Transverse	87,200	" " "
Torsion	66,300	" " "
Fusing Point.....	1040	Degrees F

LARGE CAPACITY PLANT

Quick Deliveries Guaranteed

OUR SPRUCE LOGS

Are perhaps the best on the Pacific Coast. Our facilities for supplying Air-plane Spruce are unsurpassed.

A. C. DUTTON LUMBER CORPORATION

Mills
SOUTH BEND, WASH.
TACOMA, WASH.

General Sales Department
SPRINGFIELD, MASS.

Wharves, Warehouses and Storage Yards
POUGHKEEPSIE, N. Y.

A POPULAR PRICE LAND OR WATER PLANE

TWO PLACE LAND MODEL $3,000

TWO PLACE WATER MODEL $3,100

KYLE SMITH AIRCRAFT CO., -:- -:- WHEELING, W. VA.

Flying Instruction

Instructors:
Al. Boshek
Billy Brock

which will qualify students for military examinations for pilot or mechanician or for civilian aviator's license.

FLINT AIRCRAFT COMPANY, Inc.

FLINT, MICHIGAN

AIRPLANE RIMS and WHEELS

Rims furnished punched for spokes and valve, ready to be built into wheels.

Wheels supplied less tires,—complete with all parts. Made to our own design or from manufacturer's Blue Prints.

Manufactured by the oldest and best known steel rim and wire wheel makers in America.

Careful experienced workmen and best grade of materials.

Quotations gladly submitted.

The MOTT WHEEL WORKS
Utica, N. Y.

Sanders Co.

ESTABLISHED 1905
Manufacturers of

AVIATORS' CLOTHING

Leather—Cravenette, Waterproof Canvass Duck, Government Khaki, Extra Heavy Russian Linen, Army White Duck Suits and Hoods
Made to Order

Write for Catalog and Samples

Sanders Co.
218½ Indiana Ave.
Indianapolis, Ind.

The Buck Automatic Aerial Torpedo

AFTER a series of tests in Colorado, the Buck Aircraft & Munition Co., who own and control the Buck Automatic Aerial Torpedo Patents, are prepared to negotiate with Governments and other parties for production on a quantity basis.

The Buck Automatic Aerial Torpedo is an air craft equipped with a 50 H.P. Motor, and designed to carry explosives through the air to any distance up to thirty miles. A time controlled release drops the torpedo at any given distance. The entire equipment is automatic and is launched from a compressed air catapult mounted on a motor truck, the engine of which furnishes the air for the catapult.

The torpedo can be fired at any range and at any degree of the compass.

The launching of the torpedo is without shock, and consequently the most dynamically explosive materials can be carried.

The Buck Gravity Stabilizer will be used on all machines manufactured by the company.

The Buck Aircraft & Munition Co., Inc.
Ernst and Cranmer Building
Denver, Colo.

"THE TANDEM BIPLANE"

INHERENT LONGITUDINAL STABILITY

Richardson Aeroplane Corporation, Inc.
New Orleans, La.

Erie Specialty Co.

Erie, Pa.

Manufacturers

AIRCRAFT METAL PARTS, BOLTS, NUTS, CLEVIS PINS, SHACKLES, EYE BOLTS, MACHINE SCREWS, ETC., ETC.

Fittings, Forgings, Castings

We are increasing our equipment in every department—foundry, forge shop, stamping, automatic screw machines, tool and die shop.

All our products are rigidly inspected and meet all Government requirements.

Are you on our catalog mailing list?

"Flexo" Aero RADIATORS

AUTO RADIATOR MFG. CORP. Flexo LOS ANGELES CALIFORNIA

"FLEXO"—PATENTED

Having just completed large orders for the Allies we are in better position than ever to take care of our trade

AUTO RADIATOR MFG. CORP.

219-225 W. 12th STREET, LOS ANGELES, CAL.

FOXBORO TRADE MARK

AIR SPEED INDICATOR

Forewarns and Prevents Stalling

Accurately indicates the relative wind pressure, the force that holds the plane in the air.

Light and compact.

Send for Bulletin No. BI-110.

THE FOXBORO CO., Inc.

FOXBORO, MASS., U. S. A.

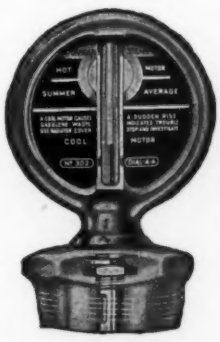
New York Chicago San Francisco

BOYCE MOTOMETER

MOTOR HEAT INDICATOR

AN ESSENTIAL SAFETY DEVICE FOR **AIRPLANES**

FOREWARNS OVERHEATING



THE MOTO-METER CO., Inc.

15 Wilbur Ave.
Long Island City
New York

TURNBUCKLES

of the

Highest Quality

Bolts and Nuts

to Satisfy the Most Exacting Requirements

Standard Screw Co.

(of Pennsylvania)

CORRY. PA.

New York Office: Woolworth Building

BUFFAIRO

AIR-SCREWS
of
PROVEN PROFICIENCY

Detailed information upon request

BUFFALO AEROPLANE CORP.
BUFFALO, N. Y. U. S. A.
Cable Address, "BUFFAIRO"

Type "B1"

Type "B2"

All recognized builders of airplane motors in America use *Zenith* on their product.

Zenith Carburetor Company

New York DETROIT Chicago

ROEBLING

AIRCRAFT WIRE
STRAND CORD

THIMBLES AND FERRULES

JOHN A. ROEBLING'S SONS COMPANY
Trenton, New Jersey, U. S. A.

For Your Flying ←Boats Use

All the prominent builders of flying boats use this glue in combination with linen between the veneer of the diagonal planking on all their flying boats, pontoons and floats. It is not only waterproof and elastic but will waterproof and preserve the linen indefinitely. Experience has shown that when this glue is used, owing to its elasticity, the inside layer of diagonal planking will remain perfectly water tight although the outside layer may be badly broken.

L. W. Ferdinand & Co.
152 Kneeland Street
Boston, Mass., U. S. A.

C. A. Herrmann

DESIGN AND CONSTRUCTION

Covering All Branches of Aviation

Bath, N. Y.

MAXIMOTOR
IN A CLASS BY ITSELF

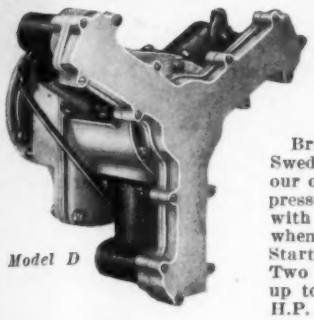
THE simplicity of our design, coupled with our eight years' practical experience constructing aviation motors, and the unlimited facilities at our command because of our location in Detroit—the heart of the motor industry in America—enable us to produce a motor that is right at a price that is right.

Send for Particulars

MAXIMOTOR COMPANY
1530 E. Jefferson Ave., Detroit, Mich.

HARRIMAN
Airplane Engines
50 to 150 H. P.

HARRIMAN AIRCRAFT MOTORS, INC.
SOUTH GLASTONBURY, CONN.


Model D

The "Perfect Starter" Booklet Sent Free on Request

Tested and Approved by U. S. Gov't.

British, Dutch, Norwegian, and Swedish Governments, as well as our own, have approved this compressed-air starter. Interference with engine is impossible, as when not in use the Perfect Starter leaves motor entirely free. Two models: "C" for engines up to 250 H.P.; "D" up to 150 H.P. Both self-charging.

Booklet Free on Request.

MOTOR-COMPRESSOR CO.
NEWARK, N. J., U. S. A.

PONTOONS
and
FLYING BOAT HULLS
Built from your designs or from ours

Palmer-Simpson Corp.
Saranac Lake, N. Y.

Aeroplane Cylinder Forgings

We make a specialty of hollow forging in dies under our hydraulic presses, aeroplane cylinder forgings of high and low carbon O.H. or alloy steels.

We have furnished cylinder forgings to practically all the engine builders in the United States.

Also Propeller Hubs, Flanges and Shafts, etc.

Miscellaneous steam hammer and hydraulic press die forgings of all types.

Quick service our specialty

TIOGA STEEL & IRON COMPANY
52nd & Grays Avenue Philadelphia, Pa., U. S. A.

Magnalite Pistons

(Aluminum Alloy)

Used as STANDARD by the most prominent Aviation Motor Manufacturers in the United States and abroad.

WALKER M. LEVETT COMPANY
417-419-421 E. 23rd St.,
NEW YORK.

Aeromarine Plane & Motor Co.

Manufacturers of

Aeroplanes and Motors

Member of Aircraft Manufacturers Association

New York Office: Times Building
Telephone, Bryant 6147

DAVENPORT SCHOOL OF AVIATION

Special inducements to students who wish mechanical instruction and actual experience in our airplane factory.

Field training under Chief Instructor

LOUIS BODER.

Write today for booklet

School and Factory at Davenport, Iowa.

Classified Advertising

10 cents a word, minimum charge $2.00, payable in advance. Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

FOR SALE—60 H. P. Elbredge airplane engine. Guaranteed good as new. Noah Smith, San Angelo, Texas.

FOR SALE—Wright H-S, practically new. Flown but eight hours; just completely overhauled. Ailerons, dual "Dep," cables all over. Good for school exhibitions, passenger carrying or sport. Will demonstrate. I. G. Semeniouk, Signal Corps Aviation School, San Diego, Cal.

WILL sacrifice controlling interest in two passenger 100 H. P. airboat. Will demonstrate. Address Box 97.

WANTED—20 to 35 H. P. aero motor, 2 or 3 cylinder. John Miller, 1211 E. Franklin Ave., Lansing, Mich.

WANTED—Strictly first class airplane draughtsman, with extensive experience in modern airplane companies, as assistant aeronautical engineer in our factory. Address Davenport Aviation School, Davenport, Ia.

WANTED—Aeroplane motor. 80 H. P. or over. State particulars. Must be cheap for cash. Moler Aviation Instructors, Inc., 105 S. 5th Ave., Chicago, Ill.

Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of all companies listed below. **Names of Advertisers in this issue are printed in heavy face type.**

ACETYLENE WELDING AND CUTTING

Davis-Bournonville Co.
Searchlight Co.

ACCESSORIES AND INSTRUMENTS

DuVivier, Earnest J.
Moto-Meter, The, Co.
O'Hara Waltham Dial Co.
Sperry Gyroscope Co.
Standard Aeronautical Co.
Taylor Instrument Companies

AIRPLANES

Aeromarine Sales and Engineering Corp.
Bates Aeroplane Co.
Benoist Aeroplane Co.
Burgess Co., The
Carter Bros. Aeroplane Co.
Cooper, John D., Aeroplane Co.
Chicago Aero Works.
Christofferson Aircraft Mfg. Co.
Curtiss Aeroplane and Motor Corp.
Dayton Wright Airplane Co.
Flint Aircraft Co.
Gallaudet Aircraft Corp.
General Aeroplane Co.
Heath, E. B., Aerial Vehicle Co.
Heinrich, The A. S. Corp.
Herrmann, Chas. A.
International Aircraft Co.
Janney Aircraft Co.
L. W. F. Engineering Co.
Lanzius Aircraft Co.
Lawrence-Lewis Aeroplane Co.
Martin Aeroplane Factory
New Jersey Aeroplane Co.
New York Aero Construction Co.
Pacific Aero Products Co.
Pierce, Samuel S., Aeroplane Corp.
Richardson Aeroplane Corp., Inc.
Rumsey Aeroplane Co.
Smith, Kyle, Aircraft Co.
Standard Aero Corporation.
Sturtevant Aeroplane Co.
Thomas-Morse Aircraft Corp.
United Eastern Aeroplane Co.
Walden-Hinners Co.
Williams Aeroplane Co.
Wittemann-Lewis Aircraft Co.
Wright-Martin Aircraft Corp.

AIRPLANE ENGINES

Aeromarine Plane and Motor Co.
Ashmusen Mfg. Co.
Atwood Aeronautic Co.
Bournonville Motors Corp.
Brooks, Thomas Preston.
Christofferson Motor Corp.
Curtiss Aeroplane and Motor Corp.
Duesenberg Motors Corp.
General Ordnance Co.
General Vehicle Co.
Gyro Motor Co.
Hall-Scott Motor Car Co.
Harriman Aircraft Motors Co., Inc.
Knox Motors Co.
Maximotor Co.
Miller, Harry A., Mfg. Co.
New Jersey Aeroplane Co.
Orio Motor Co.
Packard Motor Co.
Roberts Motor Mfg. Co.
Sterling Engine Co.
Sturtevant, B. F., Co.
Taft Pierce Mfg. Co
Thomas-Morse Aircraft Corp.
Union Gas Engine Co.
Wisconsin Motor Mfg. Co.
World's Motor Co.
Wright-Martin Aircraft Corp.

AIRPLANE PARTS

Chicago Aeronautical Supply Co.
Erie Specialty Co.
Rogers Construction Co.

ALUMINUM

Acieral Co. of America
Aluminum Castings Co.
Aluminum Co. of America
American Metal Co., Ltd.
McAdamite-Aluminum Co.
So-Luminum Mfg. & Eng. Co. (Solder)

AVIATION SCHOOLS

America Trans Oceanic Co., The
Beam School of Aviation
Christofferson Aviation School
Curtiss Training Schools
Davenport Aviation School
Dodge School of Aviation
Flint Aircraft Co.
Hall Flying School
Kendrick, B. H.
Riverside Aircraft Co.
Stinson School of Aviation
Thomas-Morse Aircraft Corp.
Williams Aviation School
Wright Field Co.

BALL BEARINGS

Hess-Bright Mfg. Co.
New Departure Mfg. Co.
Norma Company of America.
S. K. F. Ball Bearings

BALLOONS AND DIRIGIBLES

Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
French-American Balloon Co.
Goodyear Tire and Rubber Co.
Janney-Steinmetz and Co. (Hydrogen Cylinders)
Knabenshue Aircraft Corp.
United States Rubber Co.

BAROGRAPHS AND BAROMETERS

Green, Henry J.
Haustetter, A.
Sussfield & Lorch
Taylor Instrument Companies

BATTERIES

Electric Storage Battery Co.

BEARING METALS

American Bronze Co.
Fahrig Metal Co.
Magnolia Metal Co.

CARBURETORS

Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler and Schebler
Zenith Carburetor Co.

CLOCKS AND WATCHES

Ingersoll, Robt. H., and Bro.
Chelsea Clock Co.
Depollier, J., & Son
Waltham Watch Co.

CLOTHING

Abercrombie & Fitch
Meyrowitz, E. B. (goggles)
N. Y. Sporting Goods Co.
Rogers, Peet & Co.
Sanders Co.
Spalding, A. G., & Bros.

COMPASSES

Sperry Gyroscope Co.
Taylor Instrument Companies

DOPE AND VARNISH

Adams & Elting Co.
American Emaillite Co.
Chemical Products Co.
Conover, The C. E., Co.
DuPont Chemical Works
Flexible Compound Co.
National Aeroplane Co.
Pratt & Lambert
Standard Varnish Works
Valentine & Co.
Weeks & Co.

DRIFT INDICATOR

Sperry Gyroscope Co.

DYNAMOMETER

Sprague Electric Works

ENGINE PARTS

Allegheny Forging Co.
Burd High Compression Ring Co.
Doehler Die Casting Co.
Erie Specialty Co.
Fibre Finishing Co.
Gifford, Leland Co.
Gill, P. H., & Sons
Hydraulic Pressed Steel Co.
Levett, Walker M., Co.
Park Drop Forge Co.
Standard Parts Co.
Taft-Pierce Mfg. Co.
Tioga Steel & Iron Co.
Williams, J. H., & Co.
Wyman-Gordon Co.

EXHIBITION COMPANIES

The Cessna Exhibition Co.
Granburg, Gustav
Miller Aeroplane Co.
Weeks-Smalley Co.

FABRICS

Courtrai Mfg. Co.
Lamb, Finlay & Co.
McBratney, Robt. & Co.
Scott, Hutchison Co.
Whitman, Clarence & Co.

FIRE EXTINGUISHERS

Fyr-Fyter Co., The
Johns-Manville Co., H. W.
Pyrene Mfg. Co.

GASKETS

Fibre Finishing Co.

GLUE

Ferdinand, L. W., & Co.
Baeder & Adamson.

GAGES

Crosby Steam Gage & Valve Co.
Foxboro Co., The, Inc.
United States Gage Co.

HANGARS

American Bridge Co.
Anchor Corrugating Constr. Co.
Ashley Steel Bldg. Co.
Howell, Field & Goddard, Inc.
Keasby & Mattison
Milliken Bros.
Virginia Bridge & Iron Co.

LIFE PRESERVERS

Universal Safety Mattress Co.

LUMINOUS COMPOUND

Cold Light Mfg. Co.
Radium Dial Co.
Radium Luminous Material Corp.

MAGNETOS

Bosch Magneto Co.
Berkshire Magneto Corp.
Ericsson Mfg. Co.
Remy Electric Co.
Splitdorf Electrical Co.

METALS

American Vanadium Co.
Bethlehem Steel Co.
Detroit Pressed Steel Co.
Federal Pressed Steel Co.
Garland Ventilator Co.
Gueder, Paeschke & Frey Co.

MODEL AIRPLANES

Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

MOTORCYCLES

Excelsior Motor Mfg. Supply Co.
Harley-Davison Co.
Hendee Mfg. Co.
Henderson Motorcycle Co.

OILS AND LUBRICANTS

Baker Castor Oil Co.
Graphite Lubricant Co.
Gulf Refining Co.
Sheppard Ideal Oil Co.
Standard Oil Co.
Texas Co.
Vacuum Oil Co.

OIL PUMPS

Wayne Oil Tank & Pump Co.

ORDNANCE

Buck Air Craft and Munitions Co.
Colt Firearms Co.
Driggs-Seabury Ordnance Corp.
General Ordnance Co.
Maxim Silencer Co.
Savage Arms Co.

PACKING

Fibre Finishing Co.

PHOTOGRAPHY

Brock, Arthur, Jr.
Herbert & Huesgen Co.

PONTOONS

Niagara Boat Co.
Palmer-Simpson Corp.
Welen Marine Equipment Co.

PROPELLERS

American Propeller & Mfg. Co.
Aviauto Mfg. Co.
Buffalo Aeroplane Corp.
C. M. O. Physical Laboratory
Excelsior Propeller Co.
Schweizer & West Mfg. Co.
Washington Aeroplane Co.

PYROMETERS

Foxboro Co., The, Inc.
Shore Instrument & Mfg. Co.
Taylor Instrument Companies

RADIATORS

Auto Radiator Mfg. Corp.
Ajax Auto & Aero Sheet Metal Co.
A-Z Co.
Bush Mfg. Co.
El Arco Radiators Co.
Livingston Radiator Co.
Rome-Turney Radiator & Mfg. Co.
The English & Mersick Co.

SCELEROSCOPE

Shore Instrument & Mfg. Co.

SEA SLEDS

Murray & Tregurtha

SHOCK ABSORBERS

Wood, J. W. Elastic Web Co.

SPARK PLUGS

Champion Ignition Co.
Johns-Manville Co., H. W.
Pyro Ignition Co.
Rajah Auto Supply Co.
Splitdorf Electrical Co.

SPEED INDICATORS

Foxboro Co., The, Inc.
Johns-Manville Co., H. W.
Stewart Warner Speedometer Corp.

STABILIZERS

Greene Aeronautical Co.
Martin Arodynamic Stabilizer.
Sperry Gyroscope Co.

STARTERS

Bijur Motor Lighting Co.
Christensen, The, Engineering Co.
Dayton Engineering Laboratories Co.
Motor Compressor Co.
Northeast Electric Co.
Wagner-Hoyt Electric Co.

TACHOMETERS

Johns-Manville Co., H. W.
Nelson Blower & Furnace Co.
Queen-Gray Co.
Stewart Warner Speedometer Corp.
Veeder Mfg. Co.

TANKS

Janney, Steinmetz & Co.

TELEPHONES

General Accoustic Co. (Aviaphone).
Streator Electric Co.
Telautograph Corp.
Western Electric Co.

THERMOMETERS

Foxboro Co., The, Inc.
Taylor Instrument Companies

TIRES AND RUBBER

Goodyear Tire & Rubber Co.
Hodgman Rubber Co.
United States Rubber Co.

TOOLS

Browne & Sharpe
Cooper, The John D., Aeroplane Co.
Hall-Scott Motor Car Co.

TRUCKS AND TRAILERS

Federal Motor Truck Co.
Four Wheel Drive Auto Co.
Nash Motors Co.
Packard Motor Car Co.
Sechler & Co., The
Service Motor Truck Co.
White Co.

TUBING

Empire Art Metal Co.
Frasse, Peter A., & Co.

TURNBUCKLES

Aero Mfg. & Accessories Co.
Ajax Iron Works
C. E. Aeroplane Works
Dillner-Meyer Mfg. Co.
Erie Specialty Co.
National Aeroplane Co.
New York & Hagerstown Metal Stamping Co.
Standard Screw Co.

WHEELS

Ackerman Wheel Co.

WIRE

American Steel and Wire Co.
Electric Cable Co.
Roebling's, John A., Sons
Simplex Wire and Cable Co.

WIRELESS

American Radio & Research Corp.
American Wireless Tel. Co.
Cutting & Washington.

WOODS

Alcock Co., John L.
American Balsa Corp.
Chetham Lumber Co.
Delatour, J.
Dutton, A. C. Lbr. Corp.
Ludlow, Israel
Mengel, C. C., & Bros. Co.

BURGESS PRIMARY TRAINING TRACTOR, TYPE B. P.

This machine was designed by W. Starling Burgess at the request of the United States Army for a primary training tractor airplane having a practical side by side seating arrangement with duplicate controls.

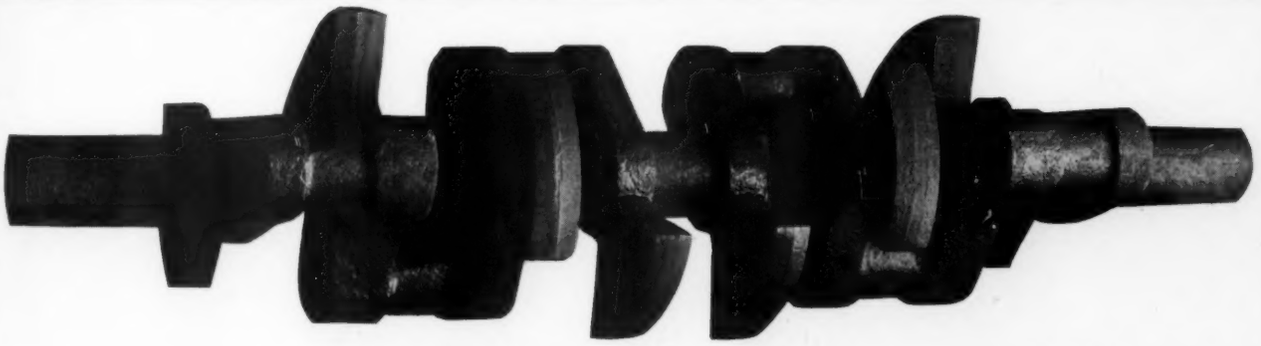
This has been accomplished without sacrificing in the least the efficiency or appearance of the machine.

It fills the urgent need found at present in the aviation schools—giving great range of control and allowing the instructor to be at side of the pupil during flight, thereby facilitating instruction.

This has been proven very satisfactorily in experimental flights as well as in the official trials through which this machine passed with great success.

THE BURGESS COMPANY, Marblehead, Mass.

MANUFACTURERS OF THE BURGESS-DUNNE AND BURGESS SEAPLANES
SOLE LICENCEES FOR THE DUNNE PATENTS



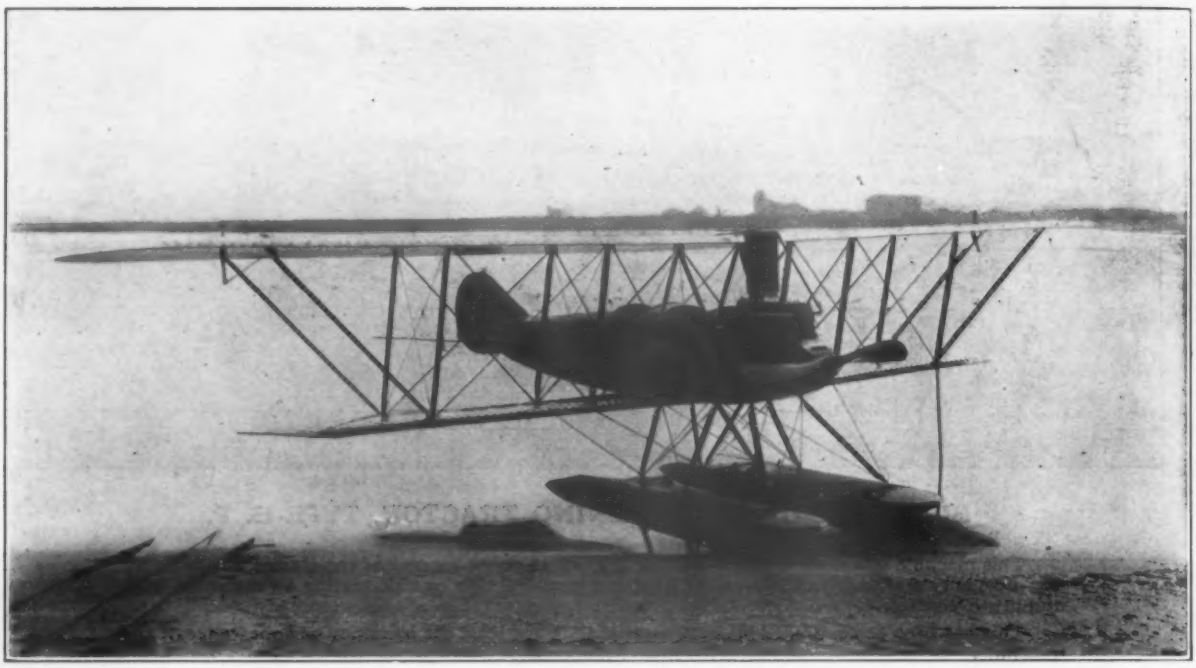
a counterbalanced aviation crankshaft . . . .

one of the 18 different
models we are now making
for 14 aviation motor companies . . .
reduces vibration and eliminates bearing pressure

We have shipped 45,854 Counterbalanced Crankshafts to June 11th, 1917

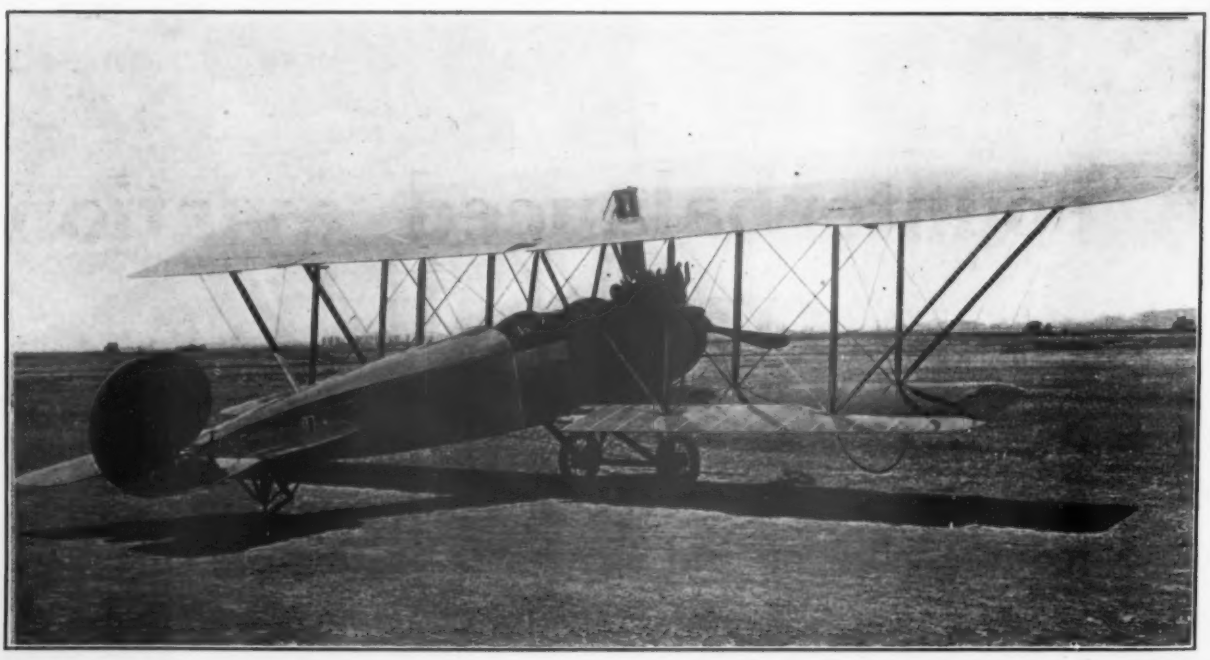
THE PARK DROP FORGE CO. CLEVELAND, OHIO

THE WILLIAMS PRINTING COMPANY, NEW YORK



THE MARTIN TWO PLACE
RECONNAISSANCE TRACTOR
MODEL R

Convertible Land and Water

Ordered by
the United States Army and Navy

Wright-Martin Aircraft Corporation